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ABSTRACT

This volume contains 10 articles describing middle school and high school technology education programs conducted in schools throughout the United States. Program descriptions, which are written by the teachers involved in the programs, are from schools in the following areas: Ann Arbor, Michigan; Chicago, Illinois; Pittsburg, Kansas; Salt Lake City, Utah; Shaker Heights, Ohio; Bellevue, Washington; Charles County, Maryland; Greece, New York; Troy, Illinois; and Conroe, Texas. Each program described involves hands-on uses of technology and features problem solving by students. Programs also stress curriculum integration with mathematics, science, and communication areas. Photos are included with the descriptions. (KC)

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# Technology Education in Action

## OUTSTANDING PROGRAMS

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INTERNATIONAL TECHNOLOGY EDUCATION ASSOCIATION

# Technology Education in Action

## OUTSTANDING PROGRAMS

INTERNATIONAL TECHNOLOGY EDUCATION ASSOCIATION

# *Foreword*

The articles in Technology Education in Action were written by teachers for use by other teachers and curriculum specialists. The firsthand reports of these teachers chronicle the extensive curriculum innovation in Technology Education in the last ten years.

Technology Education is a relatively new curriculum offered in middle schools, junior high schools, and high schools. It is concerned with technical means, their evolution, utilization, and significance with industry, its organization, personnel, systems, techniques, resources, and products and their social and cultural impact.

Many alternative teaching strategies and facilities have been examined, tested, and implemented in schools across the United States. This publication looks at distinctive programs at schools located throughout the United States. The methods described and the schools systems where the programs were implemented vary widely. But all the programs share a common goal: technological literacy.

The programs described in this book are just some of the innovative alternatives to teaching Technology Education. Others exist at schools across the nation. Nor is the development of the programs featured finished. The curriculum experts and teachers who have created these programs would be the first to admit that they are constantly making adjustments and refinements.

We urge you to carefully read about the programs described in this publications to see what components of these programs you can adopt . . . and urge you to do so!

*Richard P. Bray*
*President, 1989–90*

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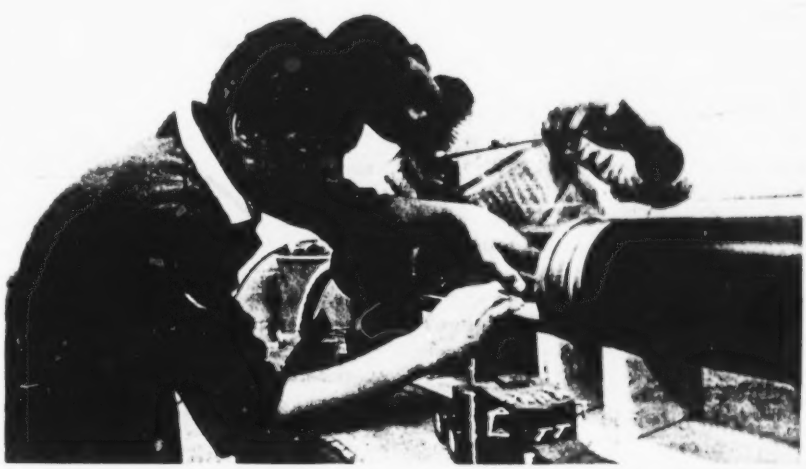
# Technology Programs

# Ann Arbor, Michigan


## Ed Ball


Ed Ball and Paul Howell, two technology education instructors at Forsythe Intermediate School, Ann Arbor, Mich., are implementing a total curriculum change this year. Instead of their former program that featured courses in hard materials, soft materials, graphics and mechanical drawing, power technology, and electricity and electronics, Ball and Howell are in the process of planning a "Technology Education" curriculum featuring courses in communication, construction, manufacturing and transportation. This program is believed to be a first for the State of Michigan, and although a substantial number of Michigan schools and instructors have taught some technology education activities in their programs, a complete technology education curriculum has not surfaced.

The purpose of this article is to outline suggested actions, activities, and the type of personal dedication necessary to begin a total technology education curriculum in a school district. For fifth year teacher Ed Ball, it was a commitment and goal worth striving for.



***A student-tested fabricated wind tunnel is used for aerodynamics testing.***

### Ann Arbor Public Schools

To begin with, the Ann Arbor Public Schools has three high schools, five intermediate schools and 26 elementary schools, as well as many other alternative educational facilities. So where does one individual begin to suggest a curriculum change in a district this large?

It begins with the conviction that change is for the better, not a political move or an ego trip, but a sincere concern for providing better and more appropriate educational opportunities for students. To demonstrate this concern is probably the biggest single task.

Many administrators and school officials believe that they have a reasonably good conception of what industrial arts/technology education is and how it should be taught. This thinking has been shaped by the actions of teachers and students over a long period of time. A departure from the norm meant changing the attitudes and points of view of a variety of individuals. (Although in Ann Arbor, a community replete with high tech industries, premier educational institutions, and R&D establishments, this was not nearly the problem that it could be in other parts of the country.)

Students, parents, teachers and counselors are just a few of the folks that will need to be enlightened on technology education. The thing to remember, however, is that the time to consider innovation for those teachers who are ready for change is *now*!

### A Personal Experience

A personal experience that occurred two years ago while teaching a power technology class (another name for what was an 18-week course in small gasoline engines) provided some of the impetus for this change. I had eighth graders learning about the applications of power through small gasoline engine lab work. We learned a lot, and I felt that overall the students had a good experience.


*The author is a teacher at Forsythe Intermediate School, Ann Arbor, Mich.*



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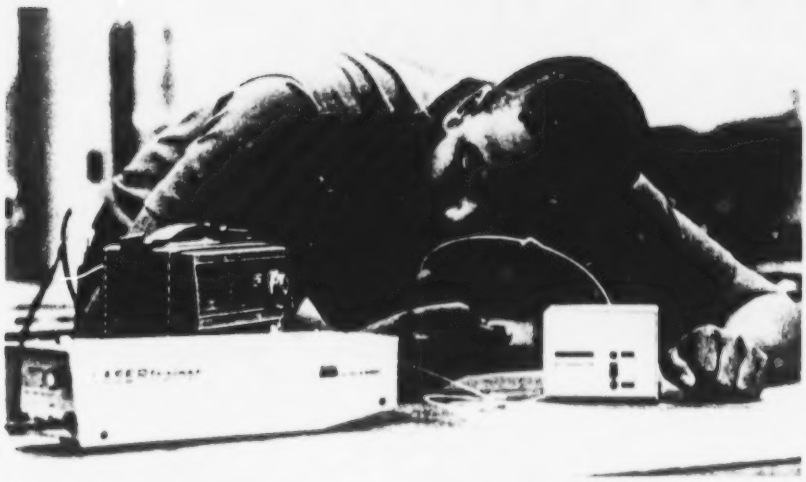

***Sound waves are transferred over a fiber optic cable.***

But, the following year I had many students who returned for 18 more weeks of small gas engines. With all of this time I had at my disposal with the same students, all of the areas of power to study, and all of the vocational courses available to the students in "Small Gas Engines and Recreation Vehicles," in the senior high, I believed we were replicating too much of the content.

From this experience I saw the need for a change, and today the eighth grader receives four to six weeks of small gas engine instruction only once as other areas of power technology are explored.

## Getting Started

With the reason(s) for change spelled out, I went out and explored my options. The best place, I felt at the time, was a the university level. I received much support from my alma mater, Eastern Michigan University in Ypsilanti. They not only helped with ideas in power technology, but in all the other areas of technology education. When they couldn't offer ideas, they matched me up with others doing neat things in their programs.

During this time period, Eastern realized the necessity for change to an even greater extent than I did as a result of their interaction with numerous teachers and school districts who were dissatisfied with their present programs and in need of assistance. So in the summer of 1985, H. James Rokusek and his colleagues at Eastern Michigan University responded by putting together a National Leadership Institute on Technology Education.

That appeared to be just what I needed. I applied for the three-week program and was subsequently accepted. Not only did the Institute give me answers and options, but it ignited a fire of incentive, desire and excitement, and provided me with a national network of people and sources.

Some 30 participants from 14 states were selected, and each one left with new goals and a quest for excellence, each one as fired up as myself—not just because we saw the need for change, but because we got some answers! What to teach, how to teach, why to teach, how and who to write to, developing action plans, and making visits to industry were all components of the program.

It was interesting to see the facial expressions of the teachers from Iowa, Colorado, Mississippi, and other places when we visited the Orion plant and GMF Robotics. All of us were overwhelmed by the advances in technology!

## Gathering Information

At this point, I knew I wanted to be a teacher of technology—not a technologist, but maybe a "shopnologist." At any rate, I dedicated the following year to educating myself to technology—writing down all I saw, asking questions of the many people with whom I came into contact, and attending as many workshops and in-service sessions as I could. I joined organizations like the Michigan Industrial Education Society, the Wisconsin Technology Education Association and the International Technology Education Association.

Here is where I found other teachers like myself, trying to beg, borrow or steal thoughts, ideas, and sources from educators in our field. Many were teachers just like me. Some had a lot of ideas, some fewer, but all of them came to get something they could take back to their schools and students. With the national focus adopted by the Leadership Institute on Technology Education at Eastern Michigan University, this sort of brainstorming and networking went on during and after the Institute. The neat thing about it was that even an idea that seemed off-the-wall gave kindling to other ideas.

With large numbers of activities beginning to be developed, specific content and organizational strategies needed to be provided. That, too, is where Eastern Michigan University filled the void. They offered four, two-week courses in manufacturing, construction, transportation and energy, and communication this past summer, and have made a commitment to offer them again next year. Each of the courses were team taught by a university faculty member and secondary school teacher.

The Wisconsin Technology Education Association also concentrated on these areas of technology by conducting workshops on three successive weekends. They brought in several teachers and professors who were implementing technology education in their classes and provided morning and afternoon hands-on activities as well as instructional packets. These experiences were extremely valuable to the teachers in attendance.

Here I found other teachers, like myself, trying to beg, borrow or steal thoughts, ideas, and sources.

California University of Pennsylvania hosted Symposium VII on Technology Education in October, 1985. I was able to attend the four sessions on teaching manufacturing, construction, communication, and transportation technology, and they were most helpful.

Quite often, what you may need is out there, but you have to seek it out from fellow teachers, professional organizations, universities, and industrial establishments.

The State of Michigan, in cooperation with Michigan State University and

Eastern, planned and conducted a series of technology education workshops that were offered at six different locations around the state in the Fall of 1985.

I was fortunate to be involved in two of them as a presenter. In fact, each of the presenters had participated in Eastern's Leadership Institute on Technology Education. Although this wasn't a prerequisite, it again shows the impact made by the Institute in Michigan.

The State also asked five of us, who were presenters, to develop a curriculum package that was titled, "Activities for Teaching Technology." This package is full of ideas, transparencies, math and science principles and applications, sources, goals, etc., for teaching courses in manufacturing, construction, communication and transportation. The material will soon be made available through the Michigan Department of Education.

### Getting Money

Finally, I needed funds for some of the equipment, materials and supplies to teach technology. One such piece of equipment was a laser beam. This was needed to help students understand

Quite often, what you may need is out there, but you have to seek it out.

communication by talking over a beam of light, and introducing students to fiber optics and holograms. I worked with a number of these concepts and activities at the Institute and was impressed by the potential value of incorporating them into my curriculum.

To get the laser I wanted, I wrote a proposal for a state supported mini-grant. To my surprise, out of the 5,430 educators who applied for a grant, I was one of the 157 who received one. This past summer I made a presentation on laser technology to the State Board of Education, Superintendent of Instruction, Philip Runkel and other members of the Michigan Department of Education. This was done to determine whether the mini-grant concept and financial support were beneficial to educational programming and students.

All of these events gave me exposure, certainly, but I was rubbing elbows with some of the leaders involved with technology education at all levels. And I captured information, notes and ideas from all I saw. I wasn't out to "reinvent the wheel," but extracted bits and pieces from the best programs along with the things that I was doing, and placed them into a context that I felt was appropriate and workable.

But in addition to gathering the ideas for my classes, probably an important aspect of the Institute was the information on how to write a proposal for technology education. I wanted to be able to answer the kinds of questions that administrators, teachers, students and others could ask, and to provide a strong rationale for technology education in Ann Arbor.

Involvement with other technology education professionals was crucial, and particularly those who had gained the respect of administrators in the district. Ann Arbor is fortunate to have some outstanding technology education teachers, especially at the intermediate level. Some of the instructors have already taken steps to offer the students something very different than has been done before in technology education.

Gary Graff, of Scarlett Intermediate School, has done a great job of teaching manufacturing technology. Although labeled "soft materials," he has ventured into industrial manufacturing pro-

*TOP*
***A simple chalk test experiment helps illustrate laser beam direction.***

*BOTTOM*
***Construction technology concepts are taught using two types of model development.***

cesses and simulations. Dave Schoekel, of Slauson Intermediate, has done incredible things in the area of construction technology (again under the title of "soft materials"). In teaching communication technology, John Kaminska and Nancy Sharpless, teachers at Clague Intermediate, have developed some excellent instructional modules for teaching telecommunications, radio and television, and graphic and visual communication.

I wasn't out to reinvent the wheel, but extracted bits and pieces from the best programs.

All of these teachers have invested much time and effort in their speciality areas after seeing the need to offer students improved learning experiences.

Then there's Paul Howell of Forsythe Intermediate, who, after 14 years of teaching, chose to go back to school at Eastern Michigan University this past summer to update his knowledge in technology education. He will be the other half of the pilot program team at Forsythe this year. With these and a few others doing technology-based activities, it was a lot easier to present my proposal to the administration.

## Proposing the Change to the Administration

Actually things moved very rapidly once the technology education proposal was submitted in last February. By July, we had a commitment from our administration to support a pilot program effective this September. This all began at the building principal level. Vaughn Filsinger, a former technology education teacher and seasoned principal at Forsythe, listened and was receptive to our proposal. He was also instrumental in the formulation of a game plan.

Briefly, it entailed submitting copies of the proposal for change to the director of occupational education, the school superintendent, and the assistant superintendent for planning and development. Each played a key role in what was to become a strong commitment by our administration.

I met with each of them several times in the winter and spring months. At each meeting I was given answers, asked questions, and given assignments that I was to produce on a particular date. But when the time came to finalize a plan, everyone's homework was done and these key people went to bat for us. It was exciting. They backed us 100%.

I have to tell you that at the time I was preparing to make the proposal, the president of the Michigan Industrial Education Society and a fellow participant at the National Institute at Eastern the previous summer, Lee Schaude, and Jim Rudnick, Consultant for Industrial Arts at the Michigan Department of Education, were anxious for someone to take the initiative and develop a full-blown technology education curriculum.

When it came time to see the superintendent, Schaude and Rudnick were there with me. And Richard Stock, being the excellent curriculum person that he is, had some challenging questions to ask of all of us. But the planning and support were there, and based largely on that exchange, the decision was made to implement a pilot program of technology education at Forsythe.

## It's Worth the Work

So if you're interested in a program in which technology education is top priority, not a name or a concept, but a goal that can be operationalized, consider the work involved in just getting the necessary approvals. Now comes the

*TOP*
***The professional development of teachers is an essential ingredient of program planning and implementation.***

*BOTTOM*
***Industrial concepts and applications can be nicely illustrated with inexpensive robots.***



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actual planning and preparation needed to implement a total program.

You see, isolated activities (one or two good technology activities) aren't good enough. Neither is stating "we teach math and science principles." if you can't identify the principles, back them up with some good learning experiences, and describe how they fulfill the course objective. If you're going to take the initiative, then you're going to have to deliver the goods.

It's somewhat of a risk for a school district to provide some resources for curriculum change to one person or a very few people. Because of this risk, intensive probing by district officials must be done to assess such things as one's understanding of technology education, internal consistency, and the strength of the teachers' commitment to kids and change.

If you're going to take the initiative, then you're going to have to deliver the goods.

Think of technology education in comparison to the implementation of "New Math," that revolutionary development of the 60's. How embarrassing it would be for a district to find out publicly that the new curriculum doesn't work. Consequently, new proposals for change must be carefully reviewed and assessed.

Teachers need to develop a series of technology education activities that will reflect and operationalize the objectives of such a program. A so-called "library of activities that reflect technology" would be extremely helpful to any teacher.

These could then be shown to the math and science teachers in order to ask them about some of the underlying scientific principles. The activities could also be changed every year, so that the program can truly reflect recent technological breakthroughs in materials, processes, and events.

As one starts putting ideas together, it is always best to write them out. Writing down the idea alone is not enough; it should be written out completely. This does a couple of things. First, it permits one to know if the idea has merit, needs work, or is a solid one. Secondly, it helps you to know what you know about it. If one sees the complete idea as it is written out, it will be easier to anticipate some of the questions that will be asked. Therefore, it is best to draw out the idea and be specific in what is written.

Lastly, a plan needs to be developed, both for your benefit and for the administration's benefit. Questions are sure to be raised about your long and short term plans. The plan should be submitted in writing, so that what may be added or deleted can be done right there.

We should not be hesitant to ask for help from university personnel. This is the only way they will know what our true needs are. If many people share the same need, then who is better equipped to provide valid and reliable information?

# Technology Programs

# Chicago, Illinois

Harry Tobin

## Overview

The Chicago public schools have more than 40,000 students enrolled in industrial education programs at the high school level on an annual basis. In spite of the elimination of all seventh and eighth grade programs of industrial arts in 1980, we currently have 4,200 students enrolled in programs at this grade level. Courses range from basic drafting to CAD (computer aided drafting), machine metals to CAM (computer aided manufacturing), basic woodworking to production technology, general auto to computerized troubleshooting, basic electricity to computer maintenance, and basic printing to electronic graphic composition.

In the future when we look back at this 1985-86 school year, we will see that it was a turning point in the transition of the industrial technology programs. Serving as the administrator of these programs for the Chicago Public Schools' Department of Vocational and Technological Education, this past year was one of the most rewarding of my 31 years as a professional in industrial education. In spite of limited financial support and indifference on the part of some local school administrators, we were able to accomplish most of the goals and objectives which were set for the 1985-86 school year.

The key factor in meeting our goals was the diversity of the programs that were offered and the resources from the community that we drew upon. By using traditional and nontraditional programs, both within and outside the school system, we were able to make significant strides.

What makes the accomplishments of my staff and others in the department more significant is the proposed legislation in Illinois that relates to increasing academic high school graduation requirements. This article describes the programs that contributed to our success.

## Staff Retraining

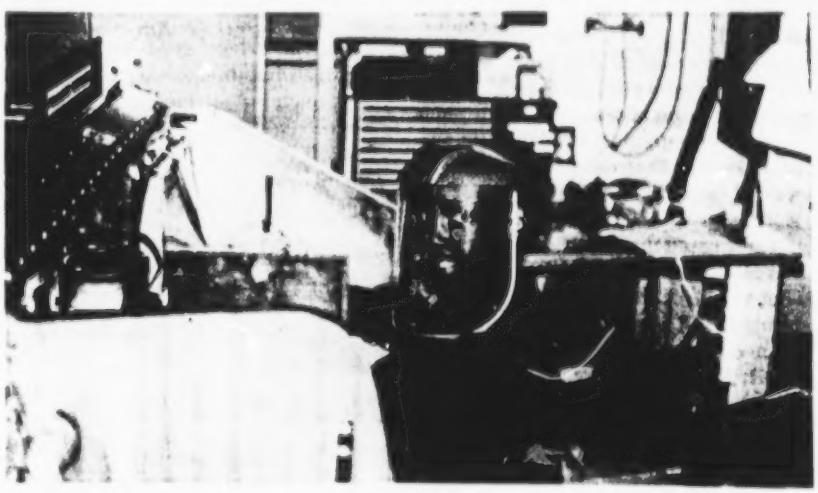
The Bureau of Industrial Technology Programs has made a commitment to adopt the Illinois Plan for Industrial Education. The Illinois Plan, very simply stated, centers on four systems which humanity is dependent upon to function in society:

- Communications
- Production
- Transportation
- Energy Utilization

To this end, a foundation has been established to serve as the basis for change to a program which is technology based; one which meet the needs of the next century.

Preparation for retraining began when Chicago volunteered to serve as a test site for state-developed curriculum materials. (This also enabled us to have input into the materials developed.)

Chicago's industrial education teachers were involved in the project as curriculum writers. Their task was to infuse



***A student works on CHOICE, a multi-media, hands-on approach to career exploration.***

*The author is Director of the Bureau of Industrial Technology Programs for the Chicago Public Schools.*





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the Illinois Plan materials and guidelines into a curriculum that would still reflect the needs of our Chicago students and schools. The plan developed—the Production Technology Implementation Guide—was completed this past January.

As the curriculum was being developed, a new production lab (or shop) capable of delivering the new curriculum was planned. For our test site, we selected Fenger High School, a school located on the far south side of Chicago. The curriculum writers/teachers organized the curriculum so that we could still use the present facilities by converting two adjoining woodshops into one workable production lab.

Then we field-tested the new curriculum in the transformed lab for one year. The students taking the classes were typical of Chicago's high school industrial education enrollment.

*An exhibit at the mini-convention.*

## Retraining Begins

For ten weeks beginning in early March we retrained 70 teachers. While the vast majority of these teachers were teaching woods, some had been working in metals or plastics. The teachers were drawn from almost every general high school, technical high school and vocational school in the Chicago Public Schools. The training took place in the remodeled lab at Fenger High School during the regular school day. (The teachers' regular classes were covered by substitutes.)

This training correlated with the curriculum developed for Chicago students by the teachers and was taught by a teacher who had already successfully implemented the curriculum in one of the city's public schools.

The retraining included units on:

- Materials and Processes
- Corporate Organization and Management
- Research and Development in Manufacturing
- Manufacturing Plant Layout
- Design and Construction of Fixtures and Jigs
- Industrial Quality Control
- Marketing
- Computer Integrated Manufacturing
- Construction
- Servicing of Manufactured Goods and Structures

In addition to these lab experiences, half of each training session was devoted to the infusion of math and science concepts into the production curriculum. (We contracted with Northern Illinois University to provide a professor to teach this portion of the retraining.)

The retaining did not stop with the Friday sessions, follow-up support services continue to be provided by two coordinators from my department. With the retraining completed, the next goal of the project was the implementation of the program to better prepare our students to become part of a productive society. Endorsements were given to 69 teachers qualifying them to teach production technology in the city's public schools. (This model was so successful that we are following it during this school year as we implement a program in Communications.)

## CAD (Computer Aided Drafting)

We have begun our own work in the area of CAD (computer-aided drafting). Over 50 drafting teachers have received training in the CAD and we plan to integrate CAD into the drafting curriculum in every school where drafting is offered.

In 40% of our schools, CAD components will be available in the drafting rooms. In the remaining school, which do not have this capability, drafting teachers will use computer resource labs for a portion of the school year.

In addition to basic and integrated CAD in the curriculum, three schools will have advanced CAD programs. These schools will have state-of-the-art equipment: CAD systems that allow the user to work with true three-dimensional geometry, not two-dimensional geometry made to look like 3-D.

## Curriculum Development in Other Areas

As of August 1986, the following implementation or field tested curriculum guides were completed. Chicago public school teachers again served as writers and evaluators during the curriculum development as these areas of the Illinois Plan are implemented.

- Production Technology—Final Stage
- Communications Technology—Initial Draft
- Transportation Technology—Initial Draft
- Consumer Electronics III-IV—Initial Draft
- Basic Machine Trades—Field Test Copy
- Construction Math/Blueprint Reading—Field Test
- Drafting/Communications—Final Stage
- Computer Aided Drafting—Final Stage
- Production Cabinetmaking—Initial Draft

As you can see the programs are in various stages of development. Most of these guides will be used in the field testing, with the entire project completed during the 1986-87 school year.

While curriculum development was our major effort, it was not the only effort

of the Department of Vocational and Technological Education nor of the teachers in the Chicago public schools in moving forward with industrial technology programs. A description of some of the other activities follows.

## Industrial Education Exhibit

Another significant event for industrial technology programs was the 22nd Annual Industrial Education Exhibit held this past May at the Museum of Science and Industry. After a few years of decline, the exhibit is gaining popularity among teachers and students.

Changing times as well as changes in the composition of the exhibit has had a great deal to do with its increased popularity. At this year's exhibition, there were over 2,000 individual exhibits occupying three floors of the museum's west wing. This past spring some of the works exhibited by teachers and students demonstrated the changing emphasis in the four Illinois Plan areas, particularly in Production Technology.

The reaction to these displays is summed up in the following excerpt an article in the *Chicago Union Teacher* entitled: "Teachers, Students Catch Public Eye at Exhibit."

"The June 1986 Chicago Union Teacher Spirit Award is given for this 22nd Annual Industrial Education Exhibit. . . . 'The important thing to remember is that these kids are doing something great, no matter what anyone says.' In these few words, Lawrence Candia, an award winning Phillips High School graphic arts teacher, spoke for all of his colleagues who worked to prepare their students for the exhibit.

" 'People will see, maybe for the first time, that these kids really can perform if given the opportunity,' Candia explained. " 'Indeed, such outstanding performance in these fields requires more than just a passing knowledge of simple math and reading skills.

" 'From the highly technical and meticulously executed scale drawings to the precisely calibrated dimensions of the scale models, it was obvious that these teachers and students had accomplished the goal of quality education in the public schools.

" 'I've seen projects here that are better than the work from some commercial shops,' said Candia who, along with a group of Phillips teachers, took the time to examine the many award winning projects submitted by other schools.

" 'Noting that business and industry representatives were on the judging panel for the exhibit, Candia said, 'This kind of show is good for the students, too. They deserve an opportunity to find out what the professionals think about their work because they will be there some day.

" 'Candia explained that many of the industrial education teachers worked during lunch periods and put in long hours after school and on weekends to shepherd students with their projects."

## Senator Newhouse Architecture Competition

We have also found competitions to be helpful in involving schools and the community in educating and expanding our student's knowledge in industrial technology. One such program is the Newhouse Architecture Competition.

Illinois State Senator Richard H. Newhouse came up with an idea for a program to acknowledge and encourage the design sense in talented Chicago public school youths. Now in its fifth year, the Newhouse Architecture Competition continues to enjoy support from its early backers including notables such as: Senator Richard H. Newhouse, the City Colleges of Chicago, the Chicago Board of Education, and the architectural and engineering firm of Skidmore, Owings & Merrill.

"People will see, maybe for the first time, that these kids can really perform . . ."

During the nine-month competition period, students are invited to participate in many programs, such as professional office tours and visits to prominent architectural projects. Related industry tours to manufacturers, suppliers and furniture showrooms inspire further interest in careers in the building industry.

The degree of difficulty in the competition varies according to the academic level of the participants. Division I—Architectural Drawing, is open to freshmen through seniors. Division II—Architectural Design, is solely for juniors and seniors. The essence of the competition is to identify and support design talent at an early age.

To assist students in the purchase of drawing and model materials, the construction industry makes significant

***The 1986 Industrial Education Exhibit featured over 2,000 individual exhibits. The article's author, Harry Tobin (far left) points out features of one student's exhibit to (with boutonnieres) then Chicago Mayor Harold Washington and General Superintendent of Schools Manford Byrd as other dignitaries look on.***



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*The grand award winner in the 1986 Senator Richard Newhouse Architecture Competition, Efrian Rodriguez, displays his entry.*

financial and materials contributions. Chicago public high school teachers and competition volunteers give generously of their time, visiting the young designers at their schools to coach them in each phase of their projects.

There were 200 entries in this contest during this past year. The 15 grand award winners served as interns this past summer with major architectural firms. These paid summer jobs introduce competition winners to the broad field of architecture. Close contacts are developed through the summer and enable students to explore the various career and educational opportunities available to them. Scholarships are awarded by the City Colleges of Chicago and other colleges.

## Principles of Technology

Current courses in the schools also contribute to our overall efforts in preparing our students for our technological society. For vocational students interested in technical careers and other secondary students wishing to further their understanding of the physical principles underlying modern technology, Principles of Technology is a course in applied science that:

- Provides an understanding of the Principles of Technology and the mathematics associated with them.
- Helps students continually adapt to the work force and its changing demands.
- Uses an appealing instructional system of audiovisual presentations, texts, demonstrations, and hands-on laboratories.
- Incorporates the findings of extensive pilot testing in comprehensive high schools and vocational centers throughout the United States and Canada.
- Meets some of the increased science requirements for high school graduation.

The following are comments from Frank Werner, a Computer Maintenance instructor at Chicago Vocational High School. He describes the benefits and contributions of this program:

"Principles of Technology is incorporated into my digital electronics classes at Chicago Vocational High School. My two classes meet 160 minutes per day. We use 40 minutes of classtime. My students are all in the 12th grade and have a good math background. All the students have completed algebra and geometry and most take additional math classes in their junior and senior year. Many of the students also have a background in physics and chemistry.

"My classes have completed Units I through IV *Principles of Technology*. We have not experienced any difficulty in understanding the concepts and formulas presented in the text. The software and hardware are very complete and self-explanatory. We had no difficulty in working the experiments. We feel that most of the material is excellent, both in concept and presentation.

"I found that my students enjoyed doing the experiments. I also noticed that the math in the units is simplified, yet complete."

> "My [Principles in Technology] classes have not experienced any difficulty in understanding the concepts and formulas . . . we feel the material is excellent."

All of the graduates in Werner's Computer Maintenance program this past year have gone to post-secondary institutions, gone on for advanced technical training, or taken jobs in industry. Seven students received scholarships to the prestigious Spartan School of Aviation in Tulsa, Okla. (Because of the emphasis upon math and coursework in the "Principles of Technology," some students were allowed to bypass some of the required related mathematics at the Spartan School.)

## Summer Orientation to Vocational Education Program

Some programs that help prepare our city's youth for a technological future, are offered in the classroom—but outside the traditional school year. Seldom has more enthusiasm been generated than for a six-week program given last summer to 440 handicapped and limited English proficient students who were entering ninth grade.

The major thrust of the orientation to this vocational curriculum/prevocational summer program was articulation between the academic subjects of mathematics, science, and English, with curriculum offerings in industry, business, computer, health, and home economics education.

The program's highlight was the CHOICE component, which provided a hands-on approach to career exploration. With the assistance of headsets, cassette tapes, and flip charts, students were exposed to the basic educational curriculum areas such as

- English
- mathematics
- science
- social studies.

The CHOICE system intertwines these basic skills with hands-on experience in self-paced, individualized career exploration modules. The overriding principle supporting the bond between the basic educational curriculum and vocational/career educational is exposure to and acquaintance with careers and potential job opportunities.

Norm Martello, an instructor in the CHOICE lab, said, "Teaching using CHOICE was extremely rewarding because the students were genuinely excited about the activities—they were so enthusiastic! Attendance was high and many students wanted to give up their lunch period or stay after school to do more. That is something that I haven't seen in a while. I have been teaching in Chicago for 28 years and it's been a long time since I saw students as excited about school as they were about CHOICE. I believe that this approach to education will reduce the dropout rate, increase reading and math achievement and help develop more satisfied, successful students."

"I have been teaching for 28 years and it's been a long time since I've seen students as excited about school . . ."

## Beyond Theory

Another different program was also offered this past summer. This program brought home to me the significance of the changes in the curriculum and our teaching as I taught a course in it. The program, *Beyond Theory*, was a summer program of academics as it relates to community and career. The institute was for Chicago public school students who were entering 7th, 8th and 9th grades in September 1986. (This experience was one of the most rewarding experiences of my teaching career. Every administrator should teach students when they have the opportunity.)

The course I taught was called Design, Produce, and Market. Two groups of students organized corporations and manufactured a tape cassette holder. While some bemoan the need for advance equipment, this course was taught in an art room without any machinery.

## Morton Career Academy

A project initiated at Morton Career Academy this summer implemented a team teaching approach to career exploration. Teachers of industrial arts, science, math, social studies, and language arts developed instructional units for sixth grade students by using a PREP module as the core for the curriculum.

PREP modules are self-paced, individualized career exploration carrels with an audio-visual component. The curriculum introduced at the sixth grade level is enhanced with a career awareness program entitled the PREP Occupational Program.

An early introduction to careers enables students to become aware of how academic subjects and technology are entwined. The curriculum developed will relate to PREP work modules as they are applicable to language arts, science, mathematics, and social studies at the sixth grade level. Activities sheets have been created to reinforce and integrate the experience directly to a specific module.

## Mini-Convention

Over 320 industrial technology teachers attended the Fifth Annual Mini-Convention. This annual meeting focuses on the future of technology education and helps to keep our teachers up to date. Last year some 35 commercial exhibitors provided an interesting array of products and instructional materials for teachers to view and try. Dr. John Wright of California University of Pennsylvania was the keynote speaker. The mini-convention also featured special seminars on computerized typesetting, computer numerical control, computer-aided design and computer-aided manufacturing.

## Conclusion

While I have focused on changes in the schools, another—important change—has also taken place in the department. This past summer the Bureau of Practical Arts and Technical Subjects was renamed the Bureau of Industrial Technology Programs.

Although we have only begun to initiate and develop these new ideas and perspectives, we have had such positive results, that we wanted to share our successes with others involved in industrial technology. This sharing should not just take place in the actual setting of the school district, but should include more conferences and networking among leaders in our field similar to the symposiums which have been held through the sponsorship of the Technical Foundation of American and others.

We should bring together practitioners who are administrators, teachers and counselors who work in the school setting, and college professors and business and community leaders who relate to industrial technology, as well as politicians as participants.

At the very least, we should set up a communications network and a hotline to be able to brainstorm significant issues which affect all of us in this exciting field of industrial technology. If we all had our act together, rather than being a "touring" cast, we would be able to provide a uniform direction on a significant issue, such as in, for example, teacher education. ITEA should be the catalyst we need.

# Technology Programs

# Pittsburg, Kansas

**John L. Iley**

Pittsburg Middle School's "Explorations in Technology" is an innovative student-managed activity-based technology education program which provides students with self-directed experiences in 20 different technology modules. Mike Neden and Max Lundquest, the developers and team teachers of the program believe that their program presents experiences which will benefit the students for the rest of their lives as they cope with the challenges of this technological world.

The middle school is in Pittsburg, Kans., a town of 18,000 people in the southeast corner of the state. Pittsburg has several small industries, a four-year state university and is surrounded by several small agricultural and mining communities. Approximately 700 students with various social and economic backgrounds are enrolled in grades six to eight at the middle school. The school is considered to be one of the most progressive schools in the state, even though of a typical small town student population.

Since the creation of the Pittsburg Middle School in 1979, industrial arts has been required for grade six and available for all three grades. Even before the development of the "Exploration in Technology" program, Pittsburg Middle School was recognized for outstanding programs in Material and Process and Power and Energy. It was also a field site for the nationally funded Occupational Versatility program. The industrial arts program received formal recognition with ITEA's Program of the Year Award in 1985.

During the summer of 1985, Neden and Lundquest began formulating plans for a new program—one which would directly address technology. The direction and ideas were triggered by discussion with business and industry leaders, articles in professional magazines, insights gained through program involvement in ITEA conferences and leadership workshops. The trend toward activity-based technology education provided the direction they ultimately chose. Both teachers explained that they "... preferred to initiate changes on our own as opposed to having changes dictated to us."

Although their previous programs were documented successes, Neden noted, "The field of technology is too broad to be limited to one or two selected areas of instruction."

In the fall of 1986, Neden and Lundquest met with school guidance counselors and district administrators to discuss the proposed curriculum ideas and changes necessary for implementing them. They had sketched out a floor plan for a proposed technology facility. The facility was to be created by combining two existing laboratories into one large open laboratory, composed of 20 different module activity areas. Their plan included a team-teaching approach using self-directed activities.

They were lucky. The administration was enthusiastic, supportive, and granted them total academic freedom. David Huffman, assistant superintendent noted, "We believe these teachers (Neden and Lundquest) are professionals, experts in the field, who know what is going on and what needs to be done." Previous successes, hard work and professional involvement had laid the foundation for the new program.

## Explorations in Technology

The new course, "Explorations in Technology" is a broad-based, technology-oriented program which provides students with self-directed experiences in 20 different technology activity modules. Each module is representative of a technology area, and addresses fundamental concepts of the topics (for example, robotics). The module also provides for exploration of the technological development and its implications for the students and the world.

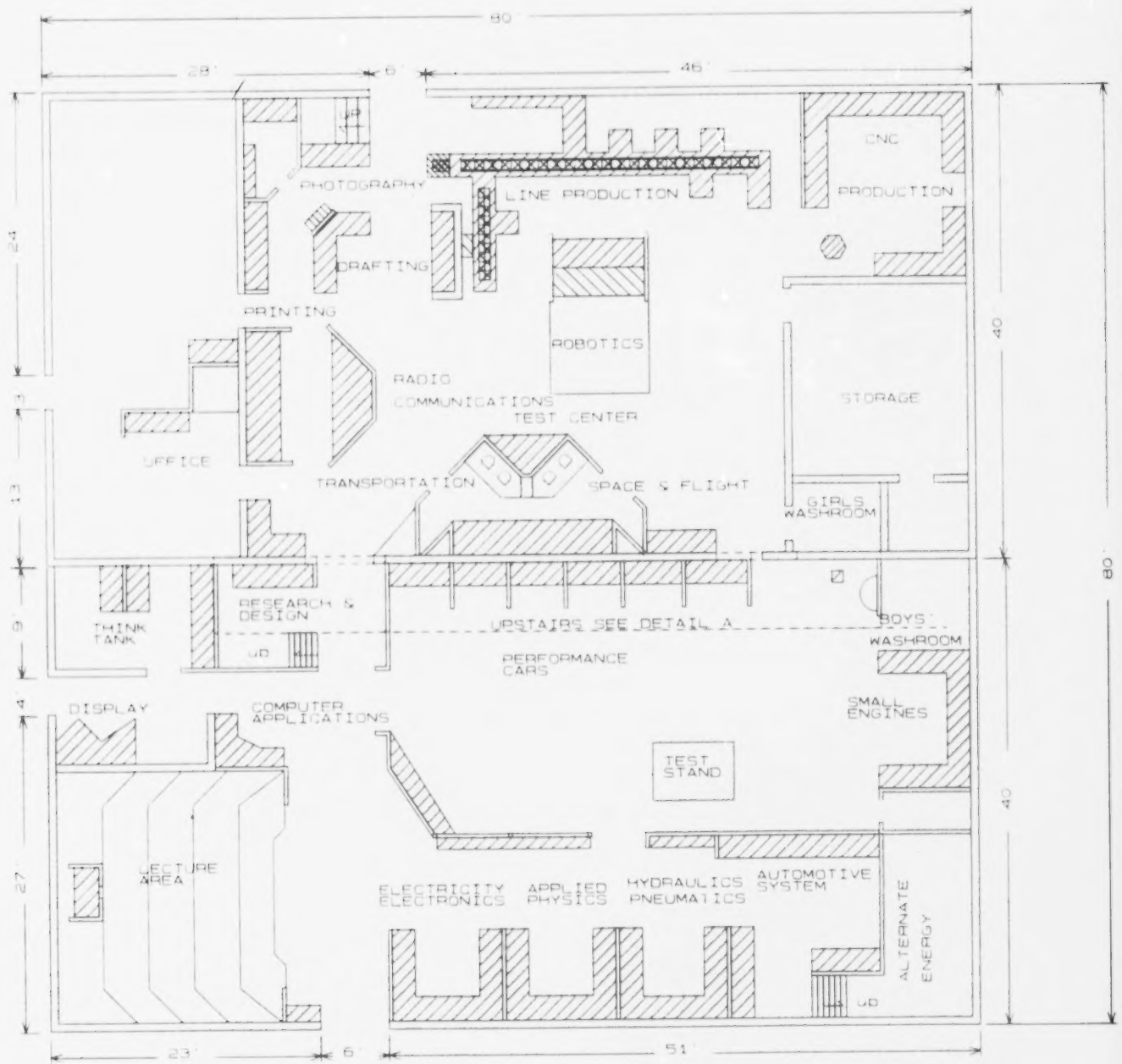
Typically, these self-directed activity modules make extensive use of audio-visual media and microcomputers, interrelate with the academic disciplines and have high interest, hands-on activities.

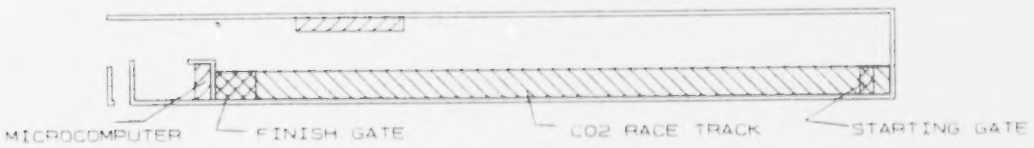
Management of the program is facilitated by:

- The extensive use of the microcomputer for scheduling students and for grading pretest/post-tests
- A student-management system
- An innovative laboratory facility, featuring a call light system

Neden described Explorations in Technology as "... a program in which 'high tech' equipment is put into practical application for this age level [12—

*The author is an assistant professor in the Department of Industrial Arts and Technology at Pittsburg State University, Pittsburg, Kans.*




DETAIL A: UPSTAIRS

14] . . . We regularly use a computer for specific assigned tasks and regard it as another tool rather than as a special isolated device used only for programming and not for common use. The computer is right in the classroom [activity module] to be used for a specific task. Students can use it for a specific task and feel good because it works for them. Successful experiences with the computer help them to be less intimidated by computers and 'high tech' equipment with which they will come in contact with in the future. The program is set up to promote success and student interest, while teaching technology concepts."

## Development of the Program

Key steps in the development of Explorations in Technology program were:

- Identifying and selecting technology units and content.
- Locationg resources, instructional materials and equipment.
- Designing a delivery system to maximize the student learning.
- Developing an organization and management system to increase the efficiency and productivity of both students and teachers.
- Constructing the facility.
- Locating funding.

One benefit of the approach Ludenquest and Neden selected—modular, self-directed activities—was that only one major piece of equipment would be needed per class per module. Students would rotate through the modules. The new facility was designed around these activity modules.

"We prefered to make changes on our own rather than having them dictated to us."

This modular approach was not new to Neden and Lundquest. Their earlier Materials and Processes classes had used the same approach. They felt their students preferred the self-directed approach, and both teachers felt it promoted self-sufficiency and productivity.

In their earlier classes, Neden and Lundquest has also used a variation of the Occupational Versatility's "student management system." Under this system, the student is responsible for keeping attendance and daily activity records allowing teachers to use their time more efficiently in instruction. A similar student management system was selected for Explorations in Technology.

The last critical area was approached by submitting a matching funds proposal under the Carl Perkins Vocational Act (Title II, Part B—Improvement, Innovation, Expansion) . . . and subsequently it was funded.

***Test Center—Consists of microcomputer, card reader and printer. Used to automatically grade, pretest, post-test and file results.***

## Facility Considerations and Design

The first reaction from outsiders when they enter Pittsburg Middle School facility is that "it doesn't look like a shop," e.g. a traditional industrial arts laboratory. It doesn't. Neden and Lundquest believed that Explorations in Technology was a new course, with an identity all its own, and required an appropriate facility.

They traded off traditional workbenches and heavy equipment replacing them with oak cabinetry and laminated surfaces, theatrical seating, media systems, high tech equipment and more. The result is a colorful new dynamic environment, which has had a positive effect on students.

### Laboratory

The lab is designed so visible control can be maintained even though the space is divided into modules. The modules are along the walls and are open so one can see through or across into other areas. Each module is self-contained, complete with the necessary instructional materials, references, supplies, tools and equipment.

The modular design is proving beneficial for class management and discipline as it provides functional boundaries for the students. They know where they are suppose to be, what needs to be done, and that assistance is available *without* leaving the module.

A call light system, similar the one used in hospitals, monitors student problems. The student switches on the light above their module when he or she encounters difficulties or in accordance with module instructions. While waiting, students try to work out their own solutions. The system allows the instructors to easily monitor problems and offer assistance where needed. The call light system has eliminated discipline problems associated with students

"The call light system eliminates [many] discipline problems."

***Line Production—Students make rocket components as part of the rocket kit line production activity.***

***Mike Neden and a student observe the final milling pass of a machinable wax PMS pen base which is used in the CNC module.***

wandering around. Students are permitted to visit other areas only when a high interest activity like the bumpbot competition is taking place.

Another unique laboratory feature is the solenoid locking system used to secure student work. Each module has cabinets containing six drawers equipped with solenoid locks—one for each class period. All drawers used by a class (Period 1, for example) are unlocked simultaneously from a control center with the flip of a switch.

### Classroom

The amphitheater classroom features assigned seating, with enough college-type lecture chairs to accommodate 36 students. The area is equipped for media and has its own sound system and microphone. Lundquest and Neden have found the mike has is a definite plus in maintaining student attention.

## Modules

### Determining the Modules to be Taught

Neden and Lundquest admit that they "started with modules that we felt comfortable with and that would reflect technology education. We paid attention to the technology areas and philosophy being written about in periodicals and discussed at conferences. We then stepped into these newer areas which could be considered nontraditional. . . . [W]ith the module approach, we have a lot of flexibility. There may be several we could pick up later as we modify our program. Some modules taught now can be dropped as they become obsolete."

### Module Components and Description

Of the 20 modules in the program, 19 are designed for a pair of students to rotate through. The remaining module, "Line Production," is done by the entire class. Modules range from one to two weeks. Students may enroll in the class three times and not repeat any modules. (Note: The Guidance Office requested this since the course replaced three semester-long courses.) Each 43-minute class period has a maximum enrollment of 36.

All modules are self-directed with a set of instructions and daily assignments. The typical module includes:

- *Pretest/Post-test*—The tests are answered on computer cards which as fed into a microcomputer's card reader. The test are then graded and automatically entered into the student's file.
- *Reading Assignment*—Selected books provide related background information. Key passages are indicated in the module's instruction book.
- *Related Information*—Film strips, slide/tape series, videotapes and computer programs are used extensively for imparting information. Both commercial presentations and teacher developed material are used.
- *Activities*—Typically, activities are hands-on experiences. Some involve making a product—such as the CNC-machined pen base which the student can take home. Others remain at school—like the performance car which involves assembling and testing. In all cases, activities are designed to stimulate interest and to be fun. The emphasis in on the technological concepts, rather than the project per se.

Neden noted, "the activities need to be interesting and fun for the students, something they can be excited about. At

"Our emphasis in not on the product . . . that's a by-product."

the same time the activities must relate to the world today—not just to industry—but the whole society. We're interested in the total person. We are concerned with preparing students by looking at many aspects of technology and how these affect them daily."

Lundquest elaborates, "our emphasis is not on the project, that a by-product. If the student can experience an activity and have a take home project, that fine, but it's not foremost in our minds. We've geared the activities to be of high interest. Traditionally, a lot of projects are taken home and, after a year or two, lost or destroyed. We believe they [the students] are going to take home a good experience that they'll have for the rest of the lives."

*Students listen to the playback of their radio broadcast in the Radio Communications module.*

## The Modules and Their Activities

The modules represent the technology clusters—communication, production, power/energy/transportation. But the clusters are addressed in smaller, specific units. A brief description of some of the modules follows.

*A pair of students assemble a small engine as part of the work done during the Small Gas Engines module.*

### Orientation

Prior to working in any module, all students go through an orientation which covers:

- Organization and management of the course
- An introduction and overview of technology, discussing what technology is, its history and how it affects the whole world
- Measurement
- Safety
- Media and computer operations

*After developing a design, a student begins work on a $CO_2$ car.*

### Radio Communications

This module is designed around a radio station simulator, equipped with turntables, mixers and tape recorders. A local radio station owner helped set up the simulator and donated the services of a technician, who spent a day and a half wiring the facility. The students use "real" radio station format sheets, as they write and produce commercials; put together a news broadcast; and prepare and tape a fifteen minute program for broadcast. The writing activities are interrelated with the English classes.

### Line Production

The entire class participates in this

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module at the same time. Students are introduced to the free enterprise system and mass production concepts. Activities include setting up a corporation and entering into labor/management negotiation. The negotiations center on length or break, music, and disbursement of funds of snacks. Any money management does not spent on labor can be kept by management.

The line production activity involves the assembly of rocket kits for a local company. The module contains a permanent conveyor system with fixed work stations. Interviews of all students are recorded with a camcorder during the activity for play back at the conclusion of the course.

**Space/Flight**

Students begin with a videotaped presentation of the history and basics flights and do reading and writing assignments. The U.S. space program, from Mercury to the Shuttle, is presented using public domain videotapes available from NASA. Students then build a rocket with a payload compartment, shot off in conjunction with the math classes. Math students calculate the rocket's altitude using trigonometry.

**Production**

The module is designed to simulate a small production shop. Students use a series of templates, jigs and fixtures, and gages to produce the component parts of walnut or oak clock from pre-sanded wood blanks. Then the project is assembled and finished by the student.

**Small Gasoline Engines**

Four-stroke cycle engine theory and the basic systems of the Briggs and Stratton engine are shown on filmstrips. Students are required to assemble, start and disassemble a small gasoline engine.

**Research and Design**

This module uses a modified and updated version of the $CO^2$ car to stimulate interest in design, research and development activities. Emphasis is on testing and research concepts; while cutting sawing and handcrafting are deemphasized. Cars are subjected to wind tunnel tests, roll tests, and bearing friction tests. Periodically, students make test runs on a permanent, computerized test track, located on a balcony that runs the length of the laboratory. At the conclusion of the module, students make a final competition run with results recorded on a permanent computer file.

**Electricity/Electronics**

Students make a circuit and conduct a series of breadboard experiments. Upon completion, they must read and follow a schematic to properly wire a bumpbot. The teacher developed bumpbot is a high interest, remote controlled robot used in several fun activities such as the demolition derby-like competition and running mazes. There are two bumpbots per module for each of the six classes. They are assembled and disassembled and remain permanently in the class.

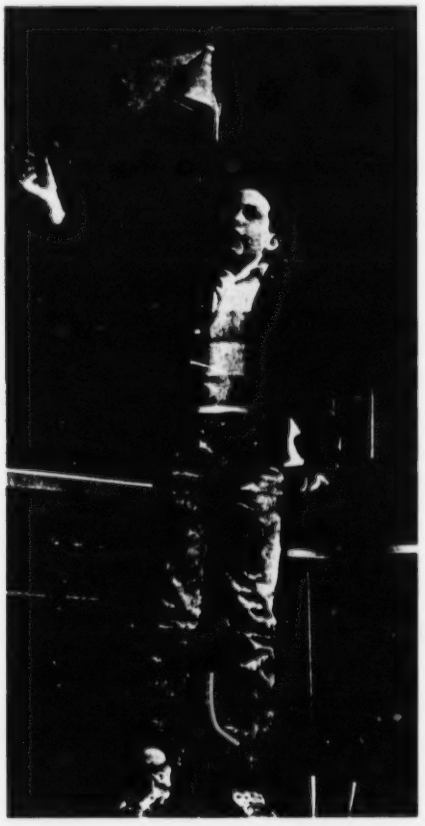
**Think Tank**

Students are required to use various problem-solving techniques to arrive at a solution. The module's second phase requires them to combine their efforts to improve on their solutions. Problem-solving activities vary throughout the semester but can include bridge building, mouse-trap vehicle and catapult.

Currently, the inventory of problem-solving activities is being enlarged to give students a broad selection. This module was developed in response to local business and industry people expressing a need for individuals who could solve problems, make decisions, work independently and work with others.

"Students indicated they would like even more time in the modules."

***Flying and testing hang gliders built by the students.***



## General Reaction to the Program

*Business*—Local businesses have reacted in support of the program by donating solar collectors, and hot water heaters, urethrae flooring materials for computerized race track and robot maze; an Omnibot robot and time and expertise in developing the modules.

*University Educators*—University personnel have assisted in software selection and equipment development, as well as providing student teachers



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which has been mutually beneficial. The university wholeheartedly supports the direction PMS has taken.

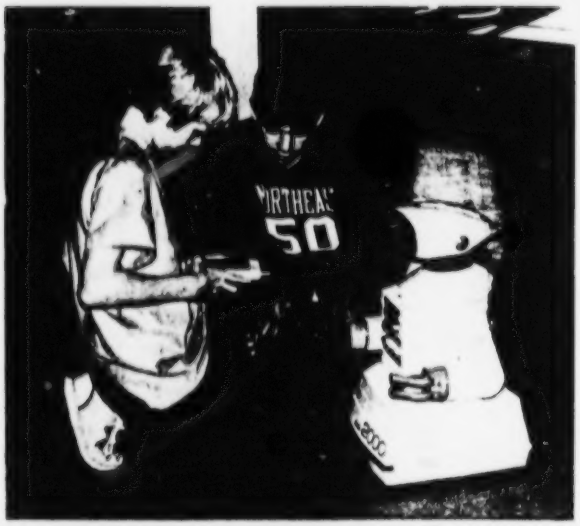
*Other Pittsburg Middle School Teachers*—Fellow teachers appreciate that their subjects are being integrated into the technology education curriculum, as well as the opportunity to work jointly on projects.

*Parents*—The instructors have continually promoted their programs through parent work night activities and an open visitation policy. Many parents have expressed their interest and excitement for the program. One parent said that last year she could hardly get her daughter to go to school, but that now her daughter wants to go even when she is sick because she wants to attend the technology class.

*Students*—A recent survey was given to obtain feedback for improving the modules, students were very positive about the program and indicated they would enjoy even more time in the modules.

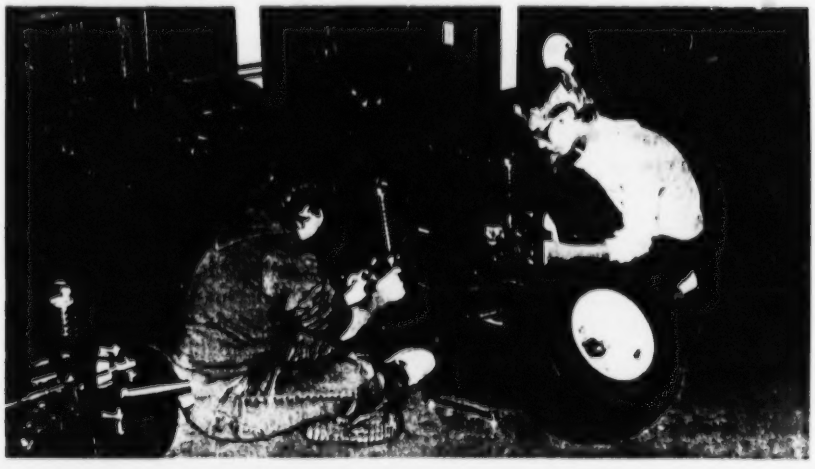
## Summary

Typical reactions to the program are characterized by Michael Dyrenfurth, a professor at the University of Missouri: "... [T]his program must be one of the most outstanding examples of creativity, ingenuity, and applied expertise that I have ever seen in the public schools ... the program mirrors the best judgment of the profession..the best thinking or local, state and national leaders."



***A teach pendant is used to program an Omnibot robot during the Robotics module.***

***A student assembles the controller for the bumpbot in the Electricity/ Electronics module.***



***The suspension system of performance car is installed by students.***

# Pittsburg, Kansas—Revisted

Mike Neden, John Iley and Patrick Winchester

The Explanations in Technology Program at the Pittsburg Middle School in Pittsburg, Kans., was featured in the previous article (see page 6). Since that time, the program has been expanded and now serves as a model program for the State of Kansas. Over 1,000 teachers, administrators and board members have visited the program since it was implemented in the Fall of 1986, and many more visits are scheduled this spring.

***Students work with hydrorobotic arm in Introduction to Technology Class***

## Basic Philosophy

Technology and change go hand in hand. The advancement of technology into almost every aspect of our lives has left us with an almost overwhelming responsibility in preparing our students to live and cope with change. Leaders in technology tell us that the body of knowledge that we are responsible for is doubling every five years, some even feel it is less than that. Remember the first time you saw a personal computer? They change so fast now that by the time you get your new computer out of the box, it is obsolete.

Conventional teaching methods and facilities have left us ill prepared to deal with such a rapidly changing phenomenon. We, in education, have traditionally been the slowest to react to change.

Technology is not easily categorized into content areas. For example, the topic of laser technology could fit in numerous content categories such as Materials/Processing, Medical Technology, Construction Technology, and so on. This problem of placing broad technologies into specific content areas contradicts the traditional order of curriculum areas and exposes the seemingly overwhelming problems involved in developing legitimate technology curriculum.

A new and innovative approach to teaching style, facility design and student management incorporated into the Exploration in Technology program in an attempt to meet this new and exciting challenge—Technology Education.

## The Program

The Explorations in Technology program is team taught by Max Lundquest, Larry Dunekack and Mike Neden. Originally the program was designed for a six-hour school day during which 36 seventh and eighth grade students per hour could explore 18 different technology modules. Students could enroll in the class for three semesters, which would allow them to explore six different module areas each semester. However, the enthusiasm and interest has

*Neden is a teacher at Pittsburg Middle School. Iley is an Assistant Professor in the Technology Department at Pittsburg State University, Pittsburg, Kans. Winchester is a graduate assistant at Pittsburg State University who did his student teaching at Pittsburg Middle School.*





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*Larry Dunekack addressing students in Mission Control.*

***An Introduction to Technology student works on plastic molding as part of the Material Processing module.***

been so great, it has become necessary to offer the course seven periods each day and to allow students to enroll in the course for four semesters if they choose.

To prepare for this expansion, six new modules are under development and scheduled to begin operation this spring. The new modules are:

- Television/Video Lab—Production
- Television/Video Lab—Camera
- Television/Video Lab—Programming
- Problem-Solving Techniques
- Structures Technology
- Computer Systems Module

These modules will combine with the existing 18 modules to provide 24 different learning areas for students to explore. The existing modules are:

- Electricity/Electronics
- Drawing, Drafting and Design
- Applied Physics
- Automobile Engine Systems
- Small Gas Engines
- Performance Vehicles
- Research and Design
- Computer Applications
- Think Tank
- Rocketry and Spaceflight
- Production Technology
- Computer Numerical Control
- Transportation
- Robotics
- Flight Technology
- Future Technology
- Desktop Publications
- Radio Communications

The entire class also participates in a Line Production module that includes labor/management negotiations, job selection procedures and a moving conveyor system that is used to produce rocket kits for a local company.

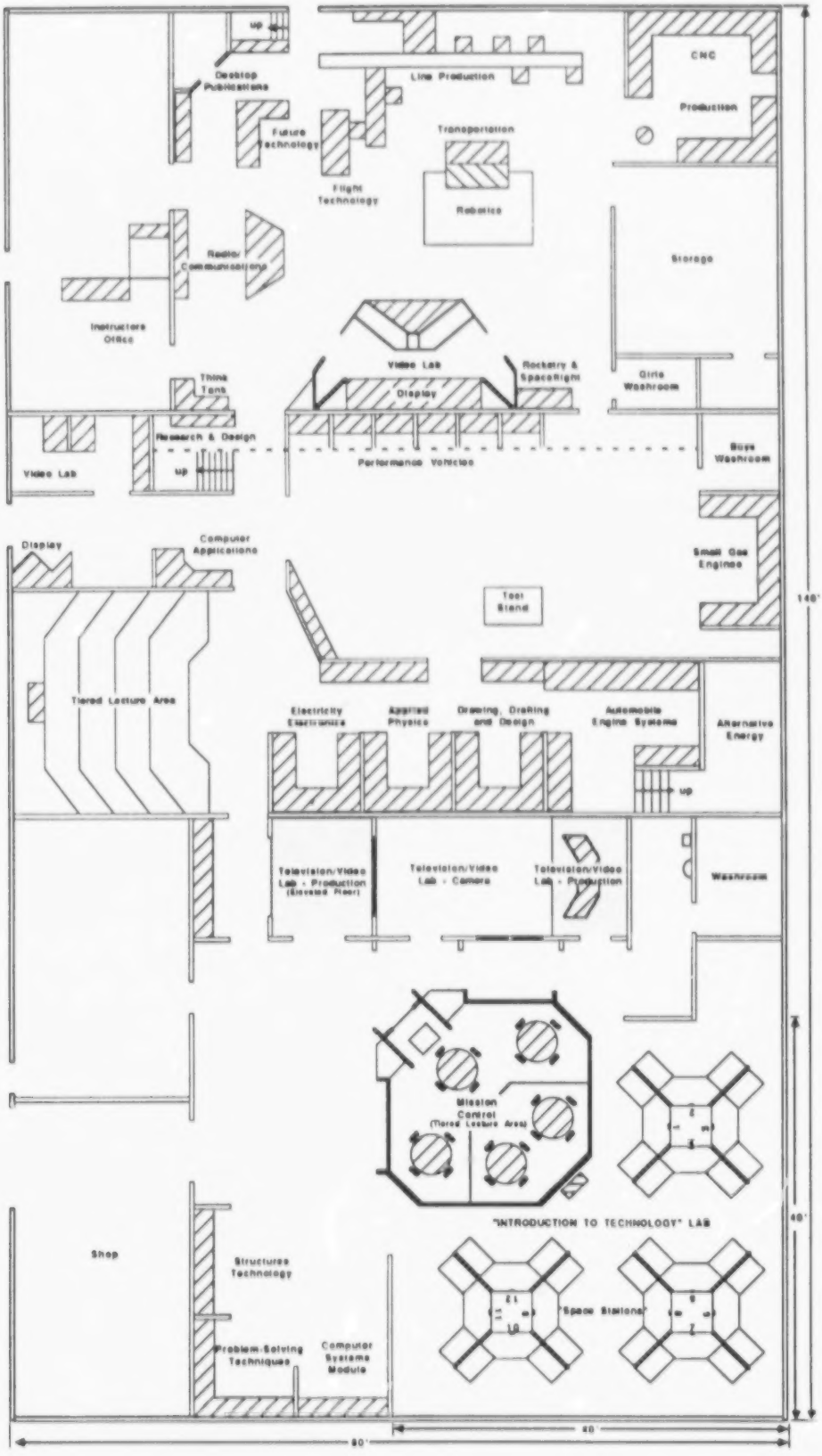
## The Delivery System

With so many different content areas to be covered, it was necessary to develop a delivery system that would allow 36 students to work at 24 different module areas at the same time. A self-directed, self-paced teaching system was developed that placed the responsibility for learning directly on each student. Two students are assigned to each module at any one time. This allows for an excellent, non-threatening learning environment for all students, regardless of their ability level.

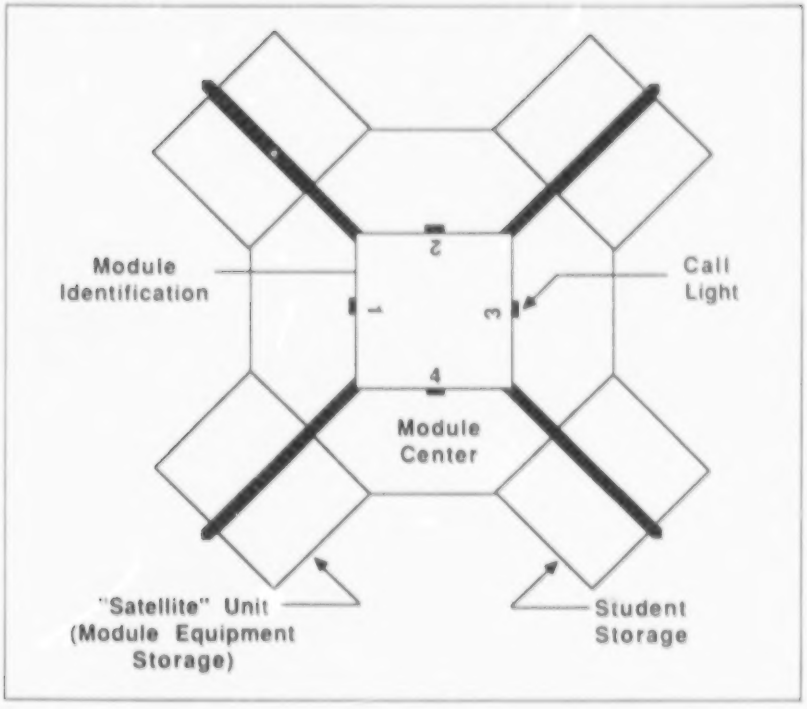
Each module contains self-directed, step by step, instructions that have been divided into daily activites and assignments. Ten days are allowed to complete the module—which is appropriate to the attention span of the middle level student. High tech equipment, video and computer programs, and reading assignments have been incorporated into each module to help maintain a high interest level and to meet the module's objectives.

The complexity of this program demands that all students know and do what is expected of them. Students in the program are responsible for vocabulary words, study questions, and pre- and post-test scores for each module. Attendance and attitude records are kept by each student. A special "Lab Permit" has been designed that has three perforated tabs attached. If a student does not perform as expected, then one of these tabs is removed and an appropriate consequence is administered. This has been a very effective method of placing the responsibility for behavior directly on each student.

Everything that the student needs to complete the scheduled activities is placed within each module. This eliminates the need for students to leave the module area they are assigned to, reducing daily discipline problems that might result with such a large number of students in one classroom.




*Technology Complex at the Pittsburg Middle School*




*An illustration of a Space Station.*

## The Facility

The design of the lab used in Exploration in Technology program creates an exciting learning environment for students. The lab design has designated module areas while maintaining complete teacher supervision. The facility was also designed to be flexible enough to allow for the addition, modification or deletion of module areas in the future. The original floor plan of the Explorations in Technology Program was included in the previous article on page 12. At that time, the facility consisted of two lab areas with a total of approximately 6,400 square feet. Last summer, the facility was nearly doubled to approximately 11,000 square feet and now includes a new sixth grade program "Introduction to Technology."

## Introduction to Technology

Last summer, Larry Dunekack was added to the Pittsburg Middle School staff. Dunekack had taught Industrial Arts and Technology for 16 years and was the Industrial Arts/Technology Supervisor for the Topeka Public Schools. Dunekack developed and teaches the Introduction to Technology program.

This program is part of a trimester rotation required of all sixth grade students at Pittsburg Middle School. During the school year, students rotate between Home Economics, Art and Technology.

With the additional classroom space obtained during the expansion of the Explorations in Technology facility, it was possible to designate a separate area for the Introduction to Technology laboratory. Dividing walls were built to separate the sixth grade lab area from the seventh and eighth grade lab. Windows were placed throughout the boundary walls so the entire lab can be observed from any location.

A two-tiered, carpeted seating area, complete with tables, chairs and a built-in sound system, was designed in one corner of the lab area. This allows a designated area for class and small group activities which was named "Mission Control." The Introduction to Technology lab is designed to accomodate up to 24 students each period.

In the remaining lab area, are three large "Space Stations." The Space Stations each consist of four learning modules. With two students assigned to each module, it is possible to have eight students in each Space Station. The Space Stations are "X" shaped and are approximately 16 feet across. Each station contains all the necessary equipment and instructions for each activity module.

Each module contains a call light system, similar to those used in the Explorations in Technology program. In each module are two satellite units made of oak and plastic laminate. One satellite is designed for equipment storage and the other for student storage. Both satellite units are on casters and may be moved to other units in the lab, maximizing the flexibility of the lab area.

The activities in the Introduction to Technology program are designed to prepare students to work in a technology laboratory and to introduce them to the many areas of technology. The module areas are designed to be completed in four class periods. All sixth grade students rotate through all 12 Introduction to Technology modules in one trimester. The delivery system and student management systems used are similar to the methods used in the Explorations in Technology program.

## Introduction to Technology Modules

The following modules have been included in the Introduction to Technology program:

- Introduction to Robotics
- Introduction to Electricity/ Electronics
- Introduction to Graphic Communications
- Introduction to Computers
- Word Processing
- Heavier than Air Flight
- Hot Air Balloons
- Material Fabrications
- Measurement
- Material Processing
- Structures
- Creative Problem-Solving

The class also participates in several group activities during the trimester.

The Introduction to Technology program has proved an excellent method to allow students to learn about technology and to let them see the opportunities that are available to them in the seventh and eighth grades.

## Summary

Teaching Technology Education demands constant review and revision of subject content, teaching methods and facility design. Although the task seems never-ending, it also provides an exciting challenge and enthusiasm that makes all of the hard work and effort worthwhile. Programs at the Pittsburg Middle School have made an attempt to address this responsibility.

# Technology Programs

# Salt Lake City, Utah

**Kim Durfee**

As I circulate through the Technology Lab 2000—observing, assisting, questioning students—I sometimes have the feeling that I'm exploring a different world. It's new and exciting, but in many ways, I'm more an alien in this world than my 7th and 9th grade students are. Doing computer simulations, testing rockets, and building robots are extensions of a reality they anticipate and accept. It's their world and they're at home in it. For me, the lab represents a completely new reality—a quantum leap from where I was just a few months ago.

"Change is, at best, uncomfortable—so we play around the edges of it."

I'm learning right along with the kids. Generally, there are as many as 20 activities going on in the lab at any one time. It's an individualized program. I've tried to stay ahead of students by learning more about computers, and by previewing the instructional units that come with the lab. But, in spite of these efforts, the students often do a better job than I do—and that's OK. I don't find that kind of situation intimidating because I don't think I have to know everything. My job is to manage the system—to send a kid off on a learning path, to monitor his or her progress, and to provide instructional support, as needed.

Usually in education, if we change at all, we try to do it gradually in carefully planned increments. Change is, at best, uncomfortable—so we play around the edges of it. Quantum change doesn't happen that way. When the difference between where you are and where you want to be is so great that you know you'll never get there unless you're willing to completely let go of the old reality—that's when you get quantum change.

I was more than willing. I was almost ready to quit teaching.

The trend in education was to reduce, if not eliminate, electives like Metal Shop, which I taught at Butler Middle School in this suburb of Salt Lake City. Industrial Arts classes in the Jordan School District were dwindling, and I found myself roving between metals and woods and wondering when Industrial Arts was going to start teaching something relevant to industry.

***A student works on a control project using pneumatic components quick connected at a Technology Platform™.***

*The author is a Technology teacher at Butler Middle School, Salt Lake City, Utah.*



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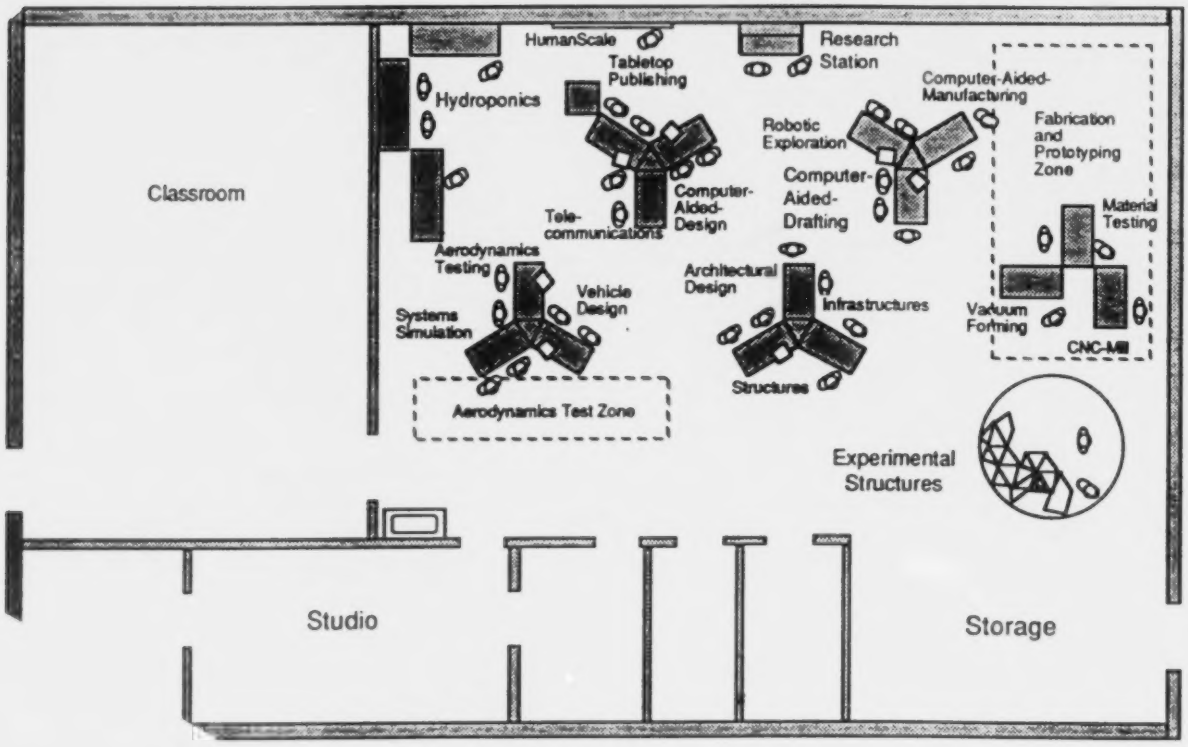



*Floor plan of the Technology Lab at Butler Middle School.*

I attended an ITEA leadership symposium in Wisconsin in 1985, and it proved to be one of the most significant experiences of my professional career. I learned how to speak up for myself more effectively. I began to be more assertive in expressing my views concerning the program at Jordan, and I started integrating a few high-tech devices into my metals classes.

"I was almost ready to quit teaching."

Then I was asked to be a part of the team to help write the Utah State Curriculum for Technology Life Careers (TLC) in the summer of 1986. As a result, Butler Middle School was designated a pilot site for the implementation of the curriculum and was given the equipment to teach 32 different high-tech experiences. Later Butler was named the model school for the state of Utah.

The Core Curriculum, as it is now known, became a requirement. It consists of trimesters in Home Economics/Health Occupations,Business/Marketing, and Industrial Arts/Technology. It is considered a "pre-vocational" program.

Then I was faced with the problem of what to do next. The district encouraged me to look for a "part two" for the program. We had to decide what to give kids after they completed the pre-vocational program. I had heard of Jim Durkin, the creator of Technology Lab 2000. So when my wife and I were given an opportunity to go to Denver and hear him talk, we jumped at the chance. My wife is a technology teacher too (at another school in the Jordan district).

To me, the most appealing feature was that the program is based on an integrated view of technology rather than a collection of interesting activities loosely collaborated under the umbrella of technology. In the Tech Lab 2000 approach, things learned in one area are called on again in a different area. I feel this is vital if students are to develop an understanding that important ideas and concepts in technology cut across the simple definition of manufacturing, construction, communication and transportation.

Another factor that was important to me was the comprehensive integrating approach. In most of the other programs I had heard about or looked at students are all engaged in the same activity at the same time. In Tech Lab 2000, students are intermixed and the individual skills that they have developed are brought to bear on cooperative investments such as forming an enterprise or operating as a communication team.

"They're finding out why they do what they do."

We ended up following Durkin around for three days and, at the conclusion of that time, I requested a Technology Lab 2000 proposal and a three-dimensional

model of the proposed lab from his company, TransTech Systems of San Diego.

My vocational director did a lot of the leg work from there on.

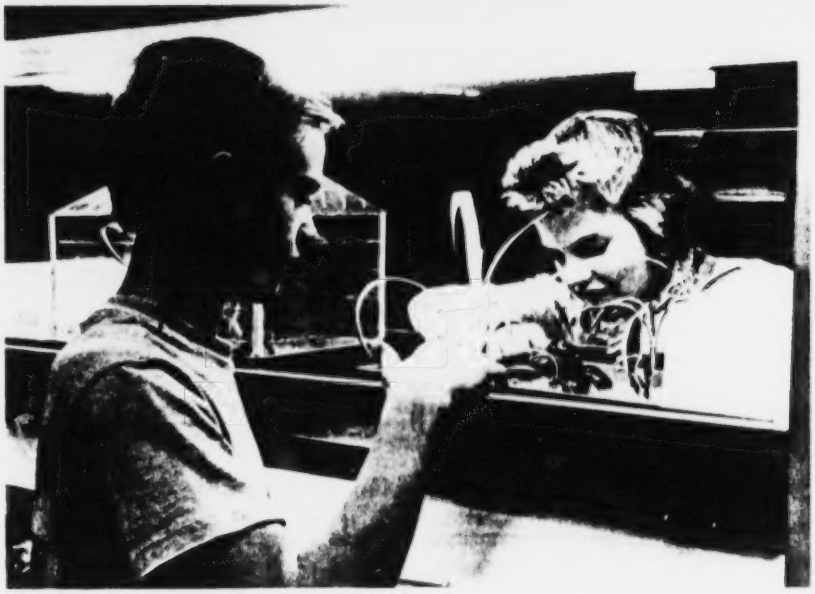
(I was fortunate in that he shared my vision that children growing up in a fast changing technologically oriented world needed to have the opportunity to directly engage the study of technology. Even though a new program in technology requires considerable effort on the part of a teacher just to keep up with the students' progress, it is very important to have a supporter at the administrative level who can relay information on your program to other administrators and occasionally given you guidance.)

"If you were to take a Model T Ford and put it on the freeway today you wouldn't expect it to compete very well, And you can't expect the curriculum of 1920 to compete any better."

The vocational director set up a presentation for the school board, the members of which, along with the superintendency and my principal, turned out to be very supportive. I took examples of high-tech apparatus with me to the board meeting and showed them to the board members.

I remember saying to them, "Back in 1920 when our present curriculum was developed, we also had just developed the first cars. Look around at the district's Industrial Arts programs. They're reflections of that 1920's curriculum. In fact, my 70-year old father learned the same things in school that I'm teaching today. Now, if you were to take a Model A or a Model T Ford and put in on a freeway today, you wouldn't expect it to compete very well. And you can't expect the curriculum of 1920 to compete any better."

Technology Lab 2000 was installed at Butler Middle School this past summer and finished just two weeks before school started. The metal shop machines, which the students and I had used the previous spring, were placed in temporary storage—supplanted by four technology islands, a fabrication center, a hydroponic greenhouse area, and an experimental structures zone. It was a totally new world—my quantum leap.



***Students monitor plant growth in the hydroponic gardens area of the lab.***

Each technology island is a cluster of three work/learn stations positioned in a triangle around a pylon which is a conduit for computer networking and power services. An individual station might be a Technology Platform™, a modeling station, or a computer console. How these three elements are combined is up to me.

I can—and often do—reconfigure the islands to better accommodate a particular set of activities the students are involved in. Everything about Technology Lab 2000 is reconfigurable.

"At first I was somewhat skeptical whether or not the students were really getting the work done."

The students work in teams of two—six students populate each island. In classes with more than 24 students the additional students are assigned to activities in the fabrication, hydroponics, and experimental structures zones—or to core project activities in other parts of the lab.

An elaborate series of learning modules comes with Technology Lab 2000. The modules give the lab purpose and direction by offering information, instruction, and involving learning activities.

The first modules deal with "Elements of Technology." The kids start off on different learning paths and then pretty soon those paths come together. For example, they learn about basic electronics and how to wire simple circuits. They have experiences building mechanisms, devices, and machines, and they learn to use the computers. These experiences prepare them for more sophisticated experiments with automation and computer control. Or they become familiar with the graphics capabilities of the Macintosh computer, use computer-aided drawing and word processing programs, and pretty soon they're doing CAD.

Students gain experience in fabrication techniques by making display modules which are then used to showcase their work. They use modular building components to construct tabletop models of gear trains, Ferris wheels, elevators, and traffic lights, which they program and control with computers. Computer-aided graphics programs allow students to design and print their own

*A student investigates the aerodynamics qualities of an airfoil in a wind tunnel.*

*A student designs a traffic light model that will be computer controlled. In the background two other students experiment with models of different configurations of gear trains.*

workstation signs, and to complete detailed scale drawings of portions of the lab. A number of activities like these are going on simultaneously at different lab stations.

At Technology Platforms™ (T-slotted stand-up worksurfaces) students use built-in supplies of air and low-voltage electricity to study electronic and pneumatic devices and to set up and test control circuitry. In a separate pneumatics activity at an adjacent modeling station, students build air compressors and pneumatic circuits using modeling components. Still other students design and test air-supported domes as part of a construction activity.

In robotics, students start with hand-manipulated robots and progress to a robotic arm controlled by a teach pendant. They also build and program robotic constructions using clear plastic bubble components that house visible gears and mechanisms. In a later series of activities, these same components are used in computer control experiments. Eventually, enlisting a variety of components, students build and program vehicles, a conveyor system, and a computer-controlled plotter.

The use of lasers in telecommunications is explored in experiments that detect outside interference in sound reception, in fiber optics applications, and in satellite simulations. We have a rocket-thrust tester, various solar-energy experiments, a computer-based flight-simulation program, a wind-tunnel for testing the aerodynamic performances of various models, hydroponic greenhouses, digitizing equipment, and a complete video production and editing system.

Several pieces of equipment—the video production system and the lasers, for instance—were acquired through the core project. The current label represents an integration of core project activities within Technology Lab 2000 and its synergistic learning program.

The heart of the lab is our computer system which came with a preconfigured hard disk drive. It feeds information and programs to other computers in the lab through a local-area network (LAN). It is housed in a small room adjacent to the lab. While this space functions primarily as my domain, students are able to access the room's laser printer from their own computers in the lab.

> "The lab represents a completely new reality—a quantum leap from where I was just a few months ago."

Each student is required to keep a detailed, up-to-date record of his or her activities and learnings in a lab notebook. At first the students were reluctant to write in their notebooks. But as they started using them, the kids quickly realized that the notebooks enabled them to look back and review everything they had learned on a particular day. The information was available to them whenever they needed it; if they had a problem or forgot something, a quick review would often give them the answers they needed. Now the notebooks are sources of great pride for the kids. The entire system fosters students' feelings of power and independence.

I have to admit though, that at first I was somewhat skeptical about whether or not the students were really getting the work done. In an individualized program with so many difference activities going on at once, students have much more autonomy than I was used to giving them. So I pulled some of their lab notebooks and checked them. I was amazed at the quality and quantity of their documentation.

The students get along well with one another. Occasionally a problem develops between the partners on a team, and when that happens, I split those particular kids up. Generally, I let students choose their own lab partners; however, I do try to team learning disabled students with the more academic kids.

The setting is surprisingly quiet, and the sailing smooth. I place a different activity guide at each station, so the kids always know what they are supposed to do. The biggest headache I have is taking role—done in the classroom adjacent to the lab. The students can look through the glass partition that separates the classroom from the lab and see their lab stations. They're always impatient to get

out there and get to work.

What appeals to students is that they get to make practical applications of science and technology principles, right along with the usual reading and writing. They're finding out why they do what they do. Many of the concepts they've studied in other classes—like math and science—make more sense to them now.

I frequently hear students say things like, "This is my best class," or "You're my favorite teacher." This year I have a better relationship with my students even though I have pushed them harder than during any other year.

I did have one problem though. When it came time to grade the students, I found it hard to make judgments. I asked my wife (a technology teacher at another school) to help me. We went through their notebooks and ended up giving most of them As and Bs. Their work is so good you could hand it to a college professor. And some college professors would be intimidated by it.

The seventh graders in particular are quite computer literate—more so than the ninth graders. I think it's because they're getting computer instruction in elementary school now—and many are getting experience at home too. It was hard to predict during the first term exactly what could be achieved. The second go-around is much easier, now I have an idea what to expect.

"Kids can accomplish a lot more than we usually give them credit for."

We had an open house about eight weeks into the first term. I sent out invitational brochures, but didn't really expect very many people to show up. I couldn't have been more surprised. The place was packed for three hours. I had 40 kids in the lab demonstrating equipment and projects. I tried to do some filming, but there were too many bodies. Parents were enthusiastic and supportive. I received virtually no negative feedback from anyone.

Students know that the employment picture is changing. Some of them have parents who have been laid off, or they're aware of companies that have gone under because they were using outmoded practices and couldn't keep up with the competition. I know the program is working when kids come in and tell me about some real-world technology story they've seen on TV or read about in the paper.

The fun in this lab is wide open. Until there's nothing new left to be invented or developed, I'm not going to be concerned. I'll need to continue to update the curriculum, and occasionally invest in new apparatus, but there's no limit to what can be taught. I have the teaching facility. It's designed to adapt to change. If I need to reconfigure the lab, it's easy. I just move things around. I do that now, and sometimes the kids come in and go to a lab station and say, "Hey, wait a minute, this isn't where I'm supposed to be." But it doesn't upset them. They understand what's going on, so they just go off and find the right station.

"Many of the concepts they've studied in other classes—like math and science—make more sense to them now."

Kids can accomplish a lot more than we usually give them credit for. Put them in the right setting, give them the equipment to work with, and provide some innovative, self-planned instructional materials to guide them. They'll jump right into the 21st century. If you're smart, you'll let them take you along.

# Technology Programs

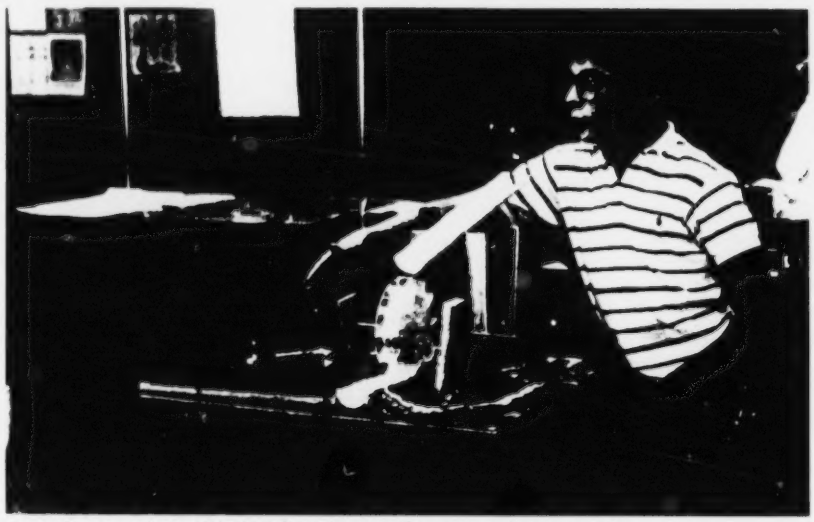
# Shaker Heights, Ohio

**Curt Johnson, Brenda H. May, and Pamela Stewart DeLong**

Integrated learning moves the student away from the traditional mastery of specific facts toward the development of practical, lifelong skills through a search for solutions in a modern, technological world. Recognizing this, three eighth grade faculty members at University School, a college preparatory school in Shaker Heights, Ohio, have coordinated the physical science, pre-algebra, and energy/power technology courses to provide their students with hands-on opportunities to solve real-life energy problems. Students are involved with experiments in science, manipulatives in math, and the design and construction of working demonstration models in technology class.

Middle school students are particularly attracted to the modern world of science and technology and are capable of theoretical understanding if they have enough concrete experience; however, they also need the discipline and precision of mathematical and scientific methods. The basic curricula in each of the math, science, and technology courses at University School seemed to be more than meeting state requirements, but too often the students questioned, "Why do we need to know this?"

In math class many of the topics seemed to be too abstract. Progress in science class often was slow because of the need to review mathematical processes; and the industrial arts curricula still reflected a manual training approach.



***A student explains his final project in the energy/power unit.***

As a result, the goals of the integrated program became:

- To develop the students' reasoning skills by improving their ability to observe, to explore, and to order their observations.
- To develop the students' ability to pose questions and to explore ways to answer their own questions.
- To develop the students' ability to communicate their findings critically to their peers and others.
- To develop inquiring minds that are better problem solvers for decision making situations both in and out of the classroom.

The following major topics of study are used to meet the goals of the integrated program:

**Conservation**

Using the Science Olympiad's "Energy Hot House Contest" rules the students applied the scientific principles of heat transfer and loss to design and construct individual containers to hold 200 ml beakers of boiling water. An hour later the water temperatures of each were measured to determine the most energy efficient container.

Research begins in the science classroom with demonstrations such as "The Heat Race I and II" by Tik Liem. Students then begin a series of experiments to compare insulating qualities of mate-

*The authors are all teachers at University School, Shaker Heights, Ohio. Johnson teaches physical science, May technology and DeLong mathematics.* *This is a refereed article.*

rials: thermal expansion of solids, liquids, and gases: the operation of utility meters: and automobile mass and horsepower as a function of gasoline requirements. "The Household Energy Game" by Smith and Jenkins of the University of Wisconsin involved every student.

Students discussed among themselves their theories on how much air whether tin foil should be employed as a vapor barrier, if the shiny side should face the inside or outside, or it made a difference.

In technology class additional research of comparative R-values of construction materials provided the basis for material choices in the project. They compared fiberglass to polystyrene insulation, wood to cardboard, and drugstore hot/cold thermal carriers to industrial freezer linings.

Some projects made extensive use of do-it-yourself home insulation materials. Styrofoam packing "peanuts," many rolls of duct tape, foam cold beverage can holders, and tin foil were among their choices.

The most efficient design was an industrial polystyrene box within a box. The beaker sat in an airtight container that side-loaded into the larger box. The greatest distance from the beaker to the outside surface was between the beaker and the top. The principle of heat rising was understood by those students.

Students were assigned a follow-up activity to determine the energy efficiency of their homes. They noted the compass direction of windows, looked for the presence of storm windows, checked for leaky faucets, timed the length of their showers and tried to find lights and appliances left on in unoccupied rooms.

In math class the students compiled their findings and constructed graphs which charted the monthly family consumption of electricity, natural gas, and gasoline. Class discussions followed the presentation of their data. The students were surprised at how widely the results varied even in similar sized homes and families.

One student was interested to discover that the new addition to his family home was well insulated, but the original section of the home was virtually uninsulated. Another found a window mounted air conditioner in a south window that was unshielded from the constant heating of the sun's rays.

One of the disappointments of the current "Hot House" project is that it served no useful purpose in the student's mind outside of a classroom exercise. Subsequently, too many of the projects, although functioning well, were sloppy and the students disposed of them as soon as the contest was over. Next year's conservation project will require that the energy efficient container be attractive and useful.

**Electricity**

Understanding electricity is one of the most difficult concepts to grasp, yet a basic knowledge of electricity becomes increasingly important for each member of society as human interaction with electrical devices and complex electronic equipment rapidly expands.

Electromagnetic radiation is demonstrated three-dimensionally using a tube within a tube system where the lumen of the smaller tube is large enough for a bar magnet or an electric wire to pass through it. The lines of force around a magnet are then visible by the arrangement of iron filings trapped between the tubes. The bar magnet can be replaced by an electric wire which demonstrates that electromagnetic lines of force surrounding a current carrying wire are similar to those surrounding a magnet.

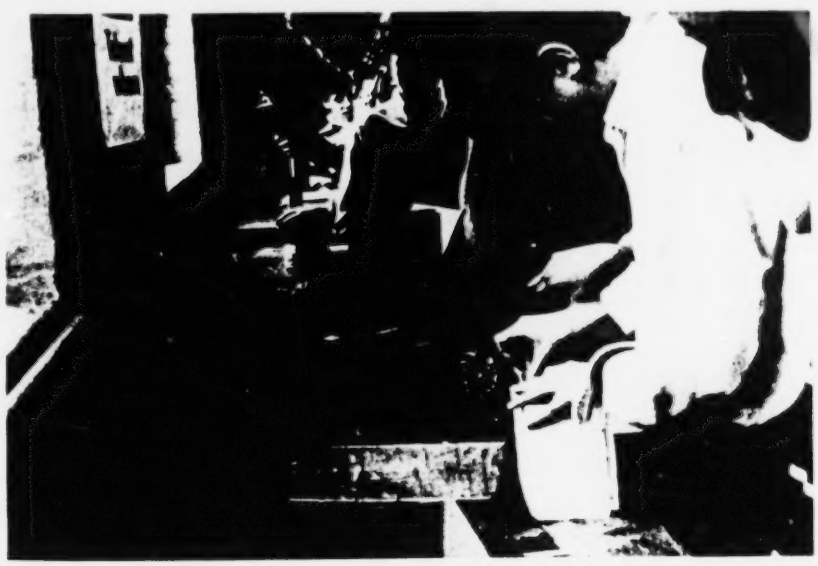
Once the presence of this invisible force is observed, the students experiment with static electricity. Various experiments demonstrate concepts of positive and negative charges and their ability to attract and repel one another, as well as charging substances by induction or contact. Ultimately students will learn how superconductors work.

A demonstration using a Beryllium-Ytterbium alloy which super conducts at the temperature of liquid nitrogen gives the students a clear picture of how a super conductor behaves. Students also construct a simple galvanometer and a telegraph system. A visit to a hydroelectric facility further solidifies how electricity is generated and what must be done with that "raw" electricity before it can be drawn from a wall plug in their homes.

In Math, students manipulate equations to determine the quantity of current, power, and resistance in various devices in both the classroom and in their homes.

The study of electrical technology includes circuitry, motors, and generators. Circuit boards with AC or DC capacity are used to develop an understanding of how electricity functions. Students wire series and parallel circuits, use commercial knife switches as well as flap hinges to break circuits, and discover (unintentionally) the importance of fuse or breaker protection.

Following a lesson on simple motors, students assembled a 1.5-volt DC motor kit. Turning the shaft by hand and



***Students begin testing the insulating efficiency of containers they constructed by filling a beaker with boiling water and placing it inside the container.***



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attaching a volt meter to the battery leads helped the students discover that the motor can be reversed and can actually produce electrical energy. A few students tried to attach one motor shaft to another to drive one motor as a generator using the first. Upon discovering that the inertia was too great for the "D" cell battery, they attached a 6V lantern battery and successfully drove their generator.

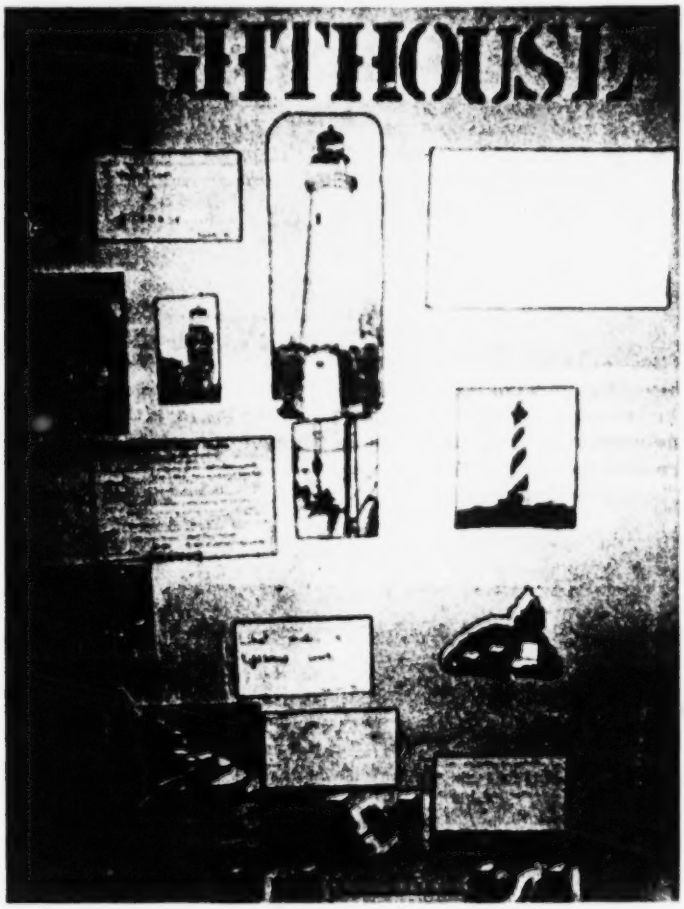
**Mechanics**

Students discover they are constantly dealing with the principles of mechanics in their everyday lives. They learn that a wheelbarrow is a third class lever, the machinery they use in the shop has pulleys, and their bicycles employ wheels and axles. Mathematically they learn how to calculate the efficiencies of these machines.

Further demonstrations display the effects of various forces on an accelerometer and the difference between speed, velocity, and acceleration. Projectile motion and escape velocity are discussed as they relate to our space program. Experiments include measuring various forces, finding resultant forces, overcoming friction, and comparing sliding and rolling friction. They also study simple machines, compound machines, and mechanical advantage.

In technology class students use an introductory Lego© building set to assemble simple and complex machines to demonstrate mechanical principles.

As they looked toward their final project they were interested in how gears function and how gear boxes are assembled. Some gear boxes were assembled with seemingly very efficient mathematical ratios until it was discovered that the gears could not be turned by hand, much less by a renewable energy source. The students learned that friction plays a significant part in mechanical design.



*An example of a student display. This one of a lighthouse.*

**Light**

In science class the study of light begins by referring back to electromagnetic radiation and demonstrating that light behaves similarly. Studies continue with the properties of light including its speed, wavelength, frequency, and its behavior in different media. Coherent light and black holes are also reviewed.

Demonstrations cover the topics of reflection, refraction, lenses, interference patterns, diffraction and lasers. Experiments include finding the focal points of lenses, discovering the effects of various colors of acetate film on the visible spectrum, and developing an analogue for the selective refraction of the automobile headlamp. In addition the students build simple periscopes and kaleidoscopes.

To stimulate more interest in the study of light, an appeal was made to the adolescent gustatory infatuation. They were asked to build a solar powered hot dog cooker. As each considered design possibilities, a highly reflective surface in a parabolic shape seemed most popular. To find the focal point of that parabola, mathematical activities were carried out by the students in their math classes. Constructing their projects at home gave the students complete freedom of choice for materials, shape, and size.

On a cloudless sunny day the students affixed their dogs to "cookers" ranging in complexity from shoe boxes lined with tin foil to solar hot water collectors in which the students planned to boil their hot dogs. The most efficient design was a ½" tin foil-covered, cardboard parabola. The parabola was so effective that it served as a "campfire" for those students whose projects turned out to be inefficient.

For the final project of the energy/power study, students were required to assim-

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ilate what they had learned about conservation, electricity, and mechanics. They research the history of capturing a renewable energy source: how it is currently being used by society, and what its future applications might be. They wrote a paper, prepared a graphic display of the statistics they gleaned from their research, and constructed a working device that used their renewable energy source. They gathered statistics of the costs involved for generating a kilowatt hour of electric power with both renewable and nonrenewable energy sources. The students speculated on the effect of the renewable energy source on society and on the environment. The goal was for each student to reach a personal conclusion to the question, "Is renewable energy the answer to society's energy problems?"

The entire project encompassed approximately four weeks. It was necessary to have check points during the period to ascertain student progress. Student/teacher conferences were scheduled at least once a week.

The format for the research paper deliberately followed the approach used in their English class. A five-page limit was set for the paper. They were graded by the science, math, and technology teachers under the advisement of the English department.

The working model was to be a device that used the renewable energy source selected. It could be a unique design or a model of a device already being employed. The requirements for the model were:

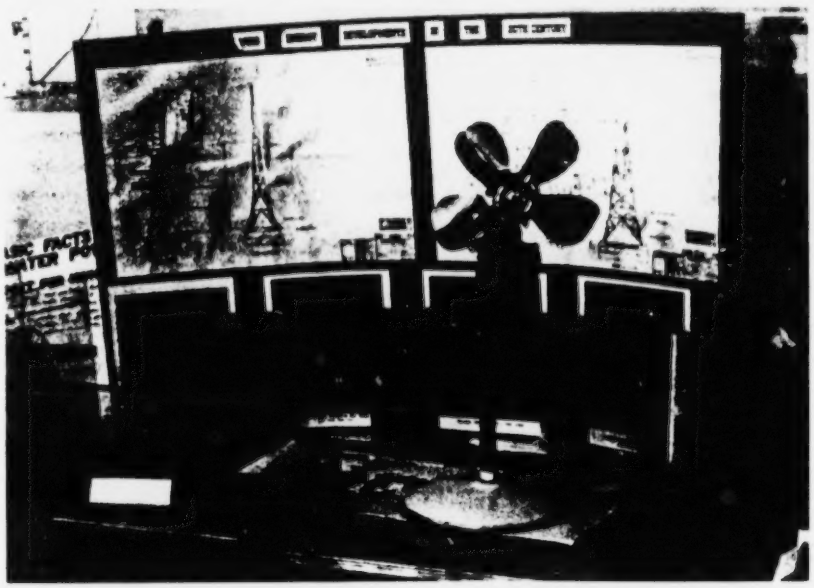
- It must function as designed and demonstrate energy conversion
- It must be of table-top size (approximately 2' × 2')
- It must be "finished" i.e., sanded, stained or painted, etc.

In addition to the model and paper, a poster illustrated statistics the students discovered about the comparative costs involved in the production of a kilowatt hour of electric power.

An oral presentation was given by each student to demonstrate and describe the model. Included in their presentation was how energy is converted, the feasibility of the model becoming a reality in the student's lifetime, the costs of producing electricity with the device, and the impact of the device on society or environment.

The students responded positively to the assignment. They needed careful guidance at the onset of the project in selecting and focusing their research. The tendency of the students was to omit the planning stage of the project which resulted in projects that, in spite of considerable work, simply did not function. Parental involvement has been positive. The final projects were placed on display in the open spaces in the school for other students and visitors to see.

While the project is continuously being evaluated and refined, it is felt this curricula improves the students' skills in discovering and using practical new information as well as enhancing their understanding of other abstract concepts. Through formal instruction and opportunities for individual discovery the students will have refined their abilities to solve real-life problems.



***One of the final energy projects that was set up on display in the classroom. The project consisted of a poster illustrating the facts the student undercovered during their study of the topic, a working model, an oral presentation and a research paper.***

***A pair of student students display their solar-powered hot dog cooker constructed as part of a unit on light—and used to cook lunch one sunny day.***



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# Technology Programs

# Bellevue, Washington

When you first walk into Kjell-Jon Rye's classroom at Bellevue High School it looks like barely controlled chaos—good-natured chaos, to be sure—and you smell what almost amounts to an incense of creativity.

The classroom of some 25 students is alive with conversation. The students work at drafting boards, in groups of two, three and four. The drafting boards, with pens, paper cutouts, pencils, adhesive tape and various cutting tools, give the impression of a busy architects's office.

But a look around the room belies the architectural impression. In one corner is a robot. Another robot, with a long, claw-like arm, sits a few feet away. Lasers glow out of a black research center attached to the lab. There is a drawing on one board of a Corvette automobile—where a student is designing a futuristic model of this sleek, high-powered car.

There are other pictures of a car—one that the students themselves designed and built, a car that has competed high mileage contests.

A senior is calculating the best pitch to use on the rotor blades for a student-designed helicopter. Another is involved in desk-top publishing.

On some of the drawing boards are paper cutouts of clothing. This particular class (there are five technology classes each day) is working on clothing design.

It's hard to believe that just three years ago, this class would have been a traditional wood shop or that the changes have come about primarily through the efforts of one teacher.

*Our thanks to Kjell-Jon Rye, Technology Teacher Emmett Watson, columnist for The Seattle Times and the Bellevue Schools for their work and aid in preparing this article.*

## The Setting

The City of Bellevue is western Washington, not far from Seattle. Bellevue High School is one of four high schools in the district.

Before Rye took over, the industrial arts program was not doing well. "There was little support for electives in general.

"Technology education has nothing to do with hardware or computers—but it has very much to do with unleashing creativity."

But the school's administration was interested in change.

When he interviewed for the teaching position four years ago, Rye said the principal asked what me what I wanted to do. "I told him 'technology' and described my prospective curriculum. I got hired, a $300 budget and told to conquer the world."

Rye began by changing the name of the classes from "industrial arts" to "technology." "Industrial arts has connotations of birdhouses and drafting mutilated blocks," he explains. "Traditional shop curriculum is based in the last century. These kids weren't even born when man walked on the moon. So why are we teaching them the same way as my grandfather was taught?"

Facility "renovation" consisted of clearing the classroom of the existing equipment. "I took five or six pick-up loads to the dump. After the room was gutted, that was it. I was ready." The reason Rye could get by with no new equipment is that to him technology education has nothing to do with hardware or computers—but it has very much to do with unleashing creativity. His students discover that there are an infinite number of solutions to any given problem. "There are many options," he says. "These students, working together, come up with amazingly imaginative solutions."

Rye's emphasis on thinking skills versus use of materials is demonstrated by the activity his introductory classes do. Rye describes what happens, "On the first day I take a sheet of paper, hold it up and ask the students what it is. They answer that the material is paper and it's in the form of a sheet. I ask them to describe what being a 'sheet' means and the characteristics of sheets. Next I discuss modifying the sheet by taking a piece of tape—a bonding agent, and a pair of scissors—a cutting tool. The students are split into teams, given a 8½" × 11" piece of paper and told they have 30 minutes to construct the tallest tower they can. The tallest have been

well over six feet."

From this basic foundation, the class moves through over projects culminating in a final engineering group project where the students must develop a solution to a specific technological problem or find an application for a future technology. Again, the work is done in teams but this time they choose the group members. The final project must be presented in a business-like manner with two- and three-dimensional models, a written technical report and an oral presentation on what they've researched and developed.

To gain support and publicity for the school's technology education program, guests are invited to see and evaluate the final displays and presentations. Regular guests include members of the private sector, print and broadcast media, students' parents and friends, members of the school board, the superintendent of schools. If the school's principals and counselors don't come, class members go to their offices to remind them. The projects are displayed from 7 am to 7 pm to secure maximum attendance.

Final projects for Rye's beginning students have included:

- Laser technology for medical applications
- Versatile human-engineered human robot
- Manufacturing and chemical refinement in zero gravity
- Computer holographic-aided design applications
- Energy efficient remodeling of residential housing
- Space station for satellite maintenance
- Adiabatic power plant for vehicles

## Goals of the Program at Bellevue

The goal of the Bellevue High Technology Education Program is to prepare students for collegiate and/or advanced vocational/technical programs and equip them with universally transferrable technological skills useful as citizens, voters and consumers.

The stated objectives of the course are that, as a result of technology education, students will:

- Experience the practical application of basic scientific and mathematical principles
- Make decisions regarding post secondary technology careers, engineering programs or service-related fields.
- Gain an in-depth understanding and appreciation for technology in our society and culture.
- Develop basic skills in the proper use of tools, machines, materials and processes.
- Solve problems, involving the tool, machines, materials, processes, products and service of industry and technology.

To achieve these objectives Rye has found several elements are vital:

- Technology Learning Activities
- Student friendly environment
- Competitive group activities
- Real world simulation
- No "right" answers
- Directional research and development
- Cross curriculum activities
- Future-oriented curriculum
- Non-comparative grading system

Rye says, "Creativity, initiative and professionalism are the three most important skills we can teach students. All our activities must lead to these elements."

## Technology Learning Activities

Rye feels that the design of the Technology Learning Activities (TLAs) is the key to the success of the class. He says, "You don't need new equipment to teach technology education. All you really need is scissors, tape, dispenser, glue, some old paper, and (sometimes) paper clips. That's how I started my program, because I didn't have anything else."

> "You don't need new equipment to teach technology education, just creativity."

Rye believes that challenge and creativity are essential to the success of a TLA. While he designs most of them himself, he says "I don't develop them entirely on my own, the kids help me. They evaluate everything I do, they help me write them, some even come up with ideas." He concludes, "It doesn't matter where you get ideas: beg, borrow, or steal them; then put them in your program."

Each TLA developed follows a self-imposed rule: It must fit on a single sheet of paper-one side for the students, the other for the teacher. With such short TLAs, students read every word because they know every word is important. But enough loop holes are left to stimulate student's creativity. "I think that telling a student to build a project from a plan sheet and made out of wood, isn't really giving them a problem, it's just following directions," says Rye.

> "I told him I wanted to do technology and described the prospective curriculum. I got hired, handed $300 and told to conquer the world."

## Student Friendly Environment

By this, Rye means that all students—no matter what their level or career ambition—can be successful. Because so much of the work is based on team effort, the students have to work in harmony with each other. It's to each student's benefit. The students learn that if one fails, they all fail.

The technology education classes are a cross-section of students and all students work with others. Rye says, "If we are a mixed society, then we have to work together in harmony. We all have to feel success and self-worth. I have the entire spectrum of students—special education kids, regular kids, gifted kids. The one thing they have to have is to be motivated, to be excited, and willing to learn." About one-third of the students are female and the classes are not tracked.

The work in the class is geared to student self actualization, that is, so each student is able to do the best they can to achieve a level that they are happy with. Rye describes what one example, "I had a severely mentally retarded kid in one of my classes, yet he was the hottest property when it came to splitting up into groups. Everyone wanted him. Why? He would follow directions,

***The students watch their toy designs tested at the local "testing bureau"—a nearby nursery school.***

he was always right there, ready to follow directions. Ten years from now, this student is going to be working in a auto parts store, and he's going to be doing the same thing he did in my class because that is a realistic level for him to achieve."

### Competitive Group Activities

While students work cooperatively as individuals they do compete as companies. And, as a company, they design, build and market a product that will solve a given problem.

While students work with one another on a group or team basis, Rye fosters fierce competition between the companies he creates to carry out class projects. While this might seem to work against the "student-friendly" environment described earlier, Rye has found his students understand the difference between the two: individually they help each other but when they are in a company they have one thing in mind—to make *their* company succeed.

Rye divides his students into teams himself for each activity. "The companies are about as equal as I can make them, to make sure they are equally competitive." This friendly competitive atmosphere has an added benefit: there is rarely any absenteeism. There is no sloughing off because of the tremendous peer pressure to succeed.

### Real World Simulation

Rye describes this as a broad-based, realistic approach to problem solving. "I try to make sure they get the whole picture." So when they do a project, it is as if they were in business and trying to make a profit.

For example, in one of the activities, students design and construct a toy for preschool children. The completed products are taken to a nursery school for grading. The grades for this project are based on the toy's performance in this real world situation as:

- 25% of the grade is based on if the toy is chosen by the children to play with;
- 25% if the children play with the toy for more than five minutes;
- 25% if the toy lasts the day; and
- 25% it the children learn anything from playing with the toy. (Rye has a child psychologist observe the toy "testing" and make this evaluation.)

### No "Right" Answers

Rye impresses on his classes that there are many solutions to the problems he presents in the TLAs, there is no one correct answer but an infinite number of correct ones.

### Directional Research and Development

Particularly his upper levels classes, students are encouraged to go off into whatever field they are interested in. "I give them suggestions, but I let them experiment. In a sense, Rye presents a project, stands by to monitor and advise, and from there the kids take the ball and run with it. He says, "I see myself as a *manager* of activities, more than a teacher."

When a student team delves off into their own area, they must first locate a mentor to provide guidance and help. With the support of these mentors, who come from industry and are experts in their fields, students leave the class knowing more about a specialized area than Rye does—or could teach them.

### Cross Curriculum Activities

Learning experience across the curriculum are also part of the program. Each TLA developed is tied in with another curriculum area such as English, the foreign languages or math. "We don't live in a world of little boxes," points out Rye, "and we shouldn't be teaching in them either. Everything we do should utilize as many other areas of education and society as possible. Students take a holistic approach to problem solving when they design, manufacture, and market their products. This lets them work from the conceptual stage to the final outcome."

### Future-oriented Curriculum

Rye works to make sure his entire curriculum looks forward, not backward. He feels we have to look at what our options for the future are, rather than what can we do. "We should be 20 years ahead of the time rather than 20 years behind."

"Each TLA developed is tied in with another curriculum area such as English, the foreign languages or math."

### Non-comparative Grading System

The students are not graded against each other. To reach their final grade, each student fills out a questionnaire and lists the grade they think deserve and the teacher does the same thing. Then the two grades are compared.

Most of the time Rye finds his grade is within a plus or minus of what the student has listed; teacher and student then negotiate the final grade. No student has ever complained about a grade even though he is one of the toughest graders in the school.

# Container Design Project

You are a packaging company which designs, manufactures and markets containers for specific products. Your company has been approached by a foreign exporter who needs to package a product which will withstand 5 kilos of pressure and will have an airspace of 1000 cc (+ or − 100 cc). Since this company is overseas, it would be cost effective to send these containers assembled and empty. Assembly must not require additional material such as glue, tape or staples.

## Action

1. Form a company with another student
2. Pick a Third World nation
3. Find a product which it could export
4. Design a container in one or two pieces
5. Make prototype and assemble container
6. Test for strength, disassemble and refine design
7. Design a company or product logo
8. Design and raw marketing for container
9. Write assembly instructions without using any words
10. Design and build a display to market export product
11. Must have at least two languages on the container
12. Display one assembled container and one flat container

You will have only two days to design and construct this packaging system and one extra day will be used in the evaluation of your company's product and display.

## Evaluation

This display will be evaluated by the students in the class, foreign exchange students in our school and any other non-U.S. citizens or immigrant who wishes to vote.

25% = Design of container
25% = Marketing of product
25% = Display of project
25% = Professional and realistic

## Teacher's Information

- This TLA is a pattern layout unit in a Communications course or it can be a fabrication of sheet material unit for construction or manufacturing.
- Invite the administration, as well as foreign language and social studies teachers because it promote cross-curricular activities and falls in line with global and cultural awareness.
- Groups must pick a foreign country and an export which has not been picked yet. Have a world almanac ready in your lab. Inform the library so they can help with research. Put the finished displays in the library.

### Student Motivation

Students in the technology education classes seem to realize what they are learning is relevant to their future. This is the reason, Rye feels, why there are few problems with student motivation.

The use of teams also aids in student motivation. For example, in attendance, pressure from other members of the student teams keeps "cuts" down and keeps all students involved. As most of the work is done in groups, the teams expect each member to show up and work. If one student doesn't show up, then there's peer pressure for him to be there the next day.

### Research Teams

In advanced classes, the students work in research teams. Teams have to get their own publicity, find funding, locate mentors, develop their own program. They must be self-motivated disciplined and directed.

One research team—a "vehicle research institute"—tried to break the

world's record for fuel efficiency. In competition, the Bellevue entry not only set a record for high school-built vehicles, but gained second place in competition against universities and private corporations.

Another group established a robotics research team which worked on a robotic arm which had been given to the technology course by the nearby Boeing Air-

"The strongest advocates for what I do are the kids."

plane Co. A laser team is currently building a laser lab and a two-ton sand table to make a hologram. They also built a movable ceiling, painted the room flat black and built a light baffle for the door.

In 1988 a space research team is scheduled.

***One team displays its work in the Container Design Project.***

### Container Design Project—A Representative TLA

An example of Rye's approach is his Container Design project (Figure 1), which won a technology project award last March. The project contains problems related to social studies, foreign language, physics and transportation technology.

The project asks two-member student teams to form a packaging company to design, manufacture and market containers for specific products. The team is create a foreign customer from a third world nation with a product (indigenous to that country) that needs packaging before it can be sold. The team must decide on a country, identify a product likely to be exported from that nation, then design and construct a package to carry the product to another country. The container developed must be easily assembled without requiring extra materials and instructions for assembling the container must be conveyed without words.

Additionally, the outside of the container must have at least two languages on it and display the market export product. The final prototype container for the project must be in a finished, market-ready form, with a student-designed company or product logo and capable of passing specific strength tests.

Project evaluation, as is customary in Bellevue's technology education courses, is by the students themselves. "Self-evaluation," Rye says, "adds an even greater air of competition." The school's foreign exchange students and "any other non-U.S. citizen or immigrant who wishes to vote" can also take part in the container critique.

The team's grade is based on:

- Container design
- Marketing proposed for the product
- Display of the product
- Professional and realistic consideration given to the problem

(The Container Design project has a two-day time limit.)

### Mentors

When they go into a specialized area, every research team must find a mentor: To answer technical questions, give professional guidance. To find a mentor, the students list the contact people they have: parents, uncles, aunts, whatever, then Rye adds the names of contacts he has.

When the robotics research team had a problem they couldn't solve, they asked around and found that a person over at the Artificial Intelligence Division at Boeing Computer Services might be able to handle it. The man, head of the AI Division, was floored that these four students asked him to work with them. And he got so excited about what they were doing, that he arranged to take the team out of school for a week and gave them in-depth intensive training in AI. Boeing sent the students back with materials and books plus a robot to make sure they could continue the project they were working on.

"Support like we have had from Boeing, Honeywell and Puget Power have made a tremendous impact on the program," says Rye. "We must forge partnerships with the business community to gain support, advice and contacts."

The mentors have done more than help the students in one particular project. Since students are told to select a research area that is of interest to them as a career possibility, often the mentors guide the students on where to go to school and what courses to take.

Kjell sums up his philosophy of teaching and modern living rather succinctly, "Because American culture is distinctly technological, it's the function of schools to give every student an understanding of the technological nature of our culture.

"This way they can make rational decisions about their own lives on a day-to-day basis. They can participate in controlling their own destiny."

# Technology Programs

# Charles County, Maryland

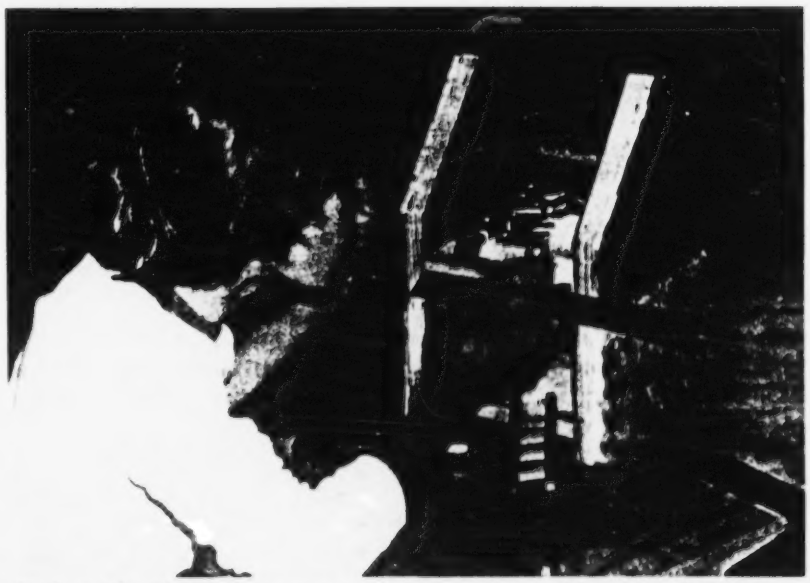
**Kenneth L. Smith**

John Hanson Middle School is located in Charles County, Md., a distant suburb of Washington, D.C. In all, the school district includes 16 elementary schools, 6 middle schools, and 4 high schools. The population that Hanson serves is a fairly typical suburban community representing a broad spectrum of socio/economic/racial backgrounds.

When the school was opened 15 years ago, then Supervisor for Technology Education Gerald Davis wanted to offer a more contemporary program for the students enrolled in the Industrial Arts classes. Davis and Principal Ronald Black decided to hire myself and Steve Crescenze to implement something different.

The program we devised has its philosophy and methods solidly linked to what we had learned during our studies at the University of Maryland. It is based from the thoughts and teaching of Donald Maley, Professor Emeritus at the university. Central to Maley's teaching, and now to ours, is the individual and the individual's growth and development within an industrial/technological society.

Of course, our program has evolved over many years. But most of the changes have been in the area of methodology rather than actual program content. Factors such as personal decisions, increased teaching experience, budget fluctuations, and educational trends have influenced this evolutionary process.



***Student John Morris does some careful measuring on his grist mill (and it actually works!).***

Our program is based on a team teaching approach. Since Crescenzewe and I had known each other since high school, we found this easy to do. With the school's open design, we can easily accommodate the 50 students of our combined classes. We strongly feel this has been a primary factor in our program's success.

## Outside Support

The support we received through the years has been substantial and broad based. Both school and county administration have always supported our efforts. Generally, we have received budgetary requests.

The department at the University of Maryland specializing in Technology Education has been very supportive. (We have worked to return the support by providing a cooperating teacher service.

*The author is a teacher at John Hanson Middle School, Charles County, Md.*

Since 1974, we have worked directly with 18 student teachers at our school. Five of those teachers now work in our school district.)

The community, too, has responded to our efforts. For example, local newspapers have carried articles about student accomplishments. This publicity always generates interest and good feelings about the program. Many parents have also offered support by providing free materials or simply saying thank you to us for providing quality education for their children.

Finally, both state and national associations have been most supportive. Our state association, Technology Education Association of Maryland (TEAM) named our school the 1986 Program of the Year. ITEA has also provided us with the opportunities to speak at statewide and national conferences in order to share our ideas with other professionals.

## Program Goals

Our program at John Hanson has very definite curricular goals. All of our classroom activities are carefully planned and executed (and occasionally refined) so that we can effectively achieve these goals. We strive to have each student do the following in our program:

- Acquire a better understanding of technology: What is it? How it changes. How does it change our lives?
- Understand that technology is actually applied mathematics and science.
- Develop better language skills through practical oral and written communication.
- Create an awareness of the social consequences spawned by technological change.
- Achieve a better understanding of his/her self and their relationship to others in an industrial/technological society.

## The Program

Sudents spend all year in our program. We have only eighth graders with approximately 20-25 students per class and two classes per a daily 42-minute period.

We begin the school year with four to six weeks of hands-on machine/tool skill activities to prepare them to function in the laboratory safely and competently during the remainder of the year. During this time, each student constructs a simple, utilitarian project.

This basic project is there to excite our students, it's their first experience in an industrial/technical setting. Because of this, we try to make them comfortable and confident in their new environment. Actually, this part of our program is reminiscent of the way industrial arts used to be taught. Students learn machine/tool skills and produce a small project. But, it serves our purpose. If we were to accomplish this and do nothing more, then our program would certainly be shallow and irrelevant.

By the end of October, our students are beginning to undertake an in-depth study of technology. It seems reasonable to begin any teaching/learning process by focusing on the individual who will be the student. So, with this as our focus, our program at Hanson begins with an understanding of where our eighth grade students are developmentally. What's important to them? What are their interests?

"Helping each student identify and select a technological area that interests them is the key to the entire program."

Now the teaching challenge begins. How do we get these young adolescents to respond to us and subsequently achieve our program goals?

## Teaching Strategies

We begin our study by helping students to think about technology. What is it? What does the word mean? Why is it important to study? An awareness of technology is achieved through numerous activities. For example, a slide show developed over many years shows former students involved in their study of technology. The feeling generated by this show is "if they can do it, . . . so can I." Classroom discussions on specific questions and field trips have proven successful orienting activities. The Washington, D.C., area offers many valuable locations to create excitement about technology.

One of our objectives early in the program is to have each student begin to identify what is important to them technologically—What interests them? One student will be fascinated by aircraft; another will express an interest in sailing ships; another might be turned on by space travel; still another wonders about old steam engines.

Helping each student identify and select a technological area that interests them is the key to the entire program. These interest areas are the basis for the student's study for the rest of the year. The choice of a topic is critical, every effort is made to have each student select a topic that truly interests them. We do not just assign topics to study arbitrarily—that would be ignoring the very foundation of our philosophy: the individual.

We do have one criteria that a topic choice must meet: The topic must have made or be making a significant and worthwhile contribution to our way of life.

Students are provided with a list of possible topics. This list is a guide; their choice does not have to appear on the list. Below are some of the topics students have studied in the past:

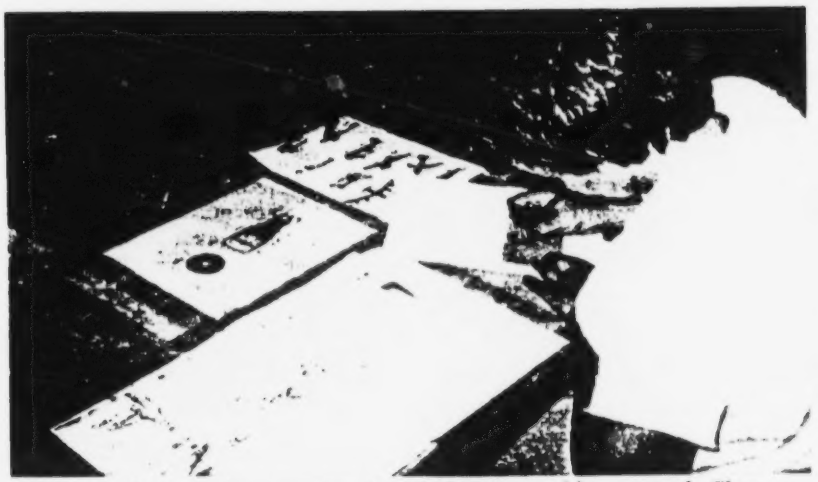
| | |
|---|---|
| Model T Ford | Clipper ship |
| Spinning wheel | Computer |
| Water wheel | Phonograph |
| Telescope | Monorail |
| Flintlock musket | Piano |
| Turbines | Windmill |
| Hovercraft | Satellites |
| Viking Ship | Log cabin |
| Catapult | River steam boat |
| Telephone | Laser |
| Oil well | Hydrofoil |
| Camera | Suspension bridge |
| Nuclear reactor | Lighthouse |
| Bicycle | Typewriter |
| Television | Printing press |
| Sewing Machine | Cannon |
| | Hot air balloon |

As you can see, these topics are examples of relevant, dramatic technologies. Each topic has certainly changed the way we live. Some are very contemporary, while others are indeed anthropological. All have served as valuable topics for study at Hanson.

## The Technology Project

Once the topics for study have been made, students begin a series of instructional activities to help accomplish all of our program goals.

The first hands-on instructional activity provides students with the skills and materials necessary to prepare a plan/



***Preparing for a seminar requires lots of planning and layout work. Then practice, practice, practice.***

drawing for a model. The model created is a by-product of the program, certainly not the primary purpose of our program.

Students begin by combing the school library, classroom library, as well as instructional packets available in the laboratory searching for pictures of their respective topics. Once these pictures have been collected, students participate in a short training program on the basics of sketching and mechanical drawing. After completing a simple drawing of the model, each student is scheduled time on a CAD/CAM system to enable them to create a final plan to be used as a guide in their laboratory activities.

"The laboratory environment provides ample opportunity for discovery of tools, machines, materials and processes."

Students now use the machine/tool skills taught in the first weeks of the class to fabricate their model. As their model begins to take shape, new skills are learned and new materials discovered. As they work to build their models, many questions are raised. Questions like:

- How do I make the wings on my airplane?
- What material should I use to make the sails on my windmill?
- How can I make my rocket engines for my space shuttle?

How much weight do I need to get my catapult to work?

So many, many questions!!

Problem-solving techniques are used extensively during the laboratory activity as each student attempts to create an authentic—even working—model. Students experiment with different materials to determine which one will be the most appropriate choice for a particular part. The laboratory environment provides ample opportunity for discovery of tools, machines, materials and processes.

In constructing this detailed model, students have almost limitless opportunities to make choices, experiment, compare, and problem solve. Most days, we are simply exhausted because the demand for assistance and guidance in our lab is just overwhelming. But the model is not the final outcome, again it's only a by-product. Its value lies in its ability to motivate and excite our eighth graders.

## Research

As the school year progresses, the students continue their efforts in the lab designing, engineering and fabricating parts for their model. Meanwhile, we direct their attention to a new area: the need to obtain knowledge about their topic.

We introduce and discuss techniques for effective research. Library skills are reviewed. In some cases, the school's Language Arts teachers assists our students with special instructional materials or by providing classtime to work on their research topics.

Soon student efforts to gather information takes on many dimensions. Certainly library time is scheduled and used, but it is only the starting point. Former students have created learning packets that contain pictures and text about specific research topics as well as suggestions on other possible sources of information on the subject.

## Research Beyond The School

Despite our work and the materials in the library, often the school's resources have very limited information about a subject. This is especially true if the technology under study is a cutting edge development. Because of this, we instigate a massive effort to guide students to resources beyond the school.

### Letter Writing Campaign

One very successful strategy has been a letter-writing campaign. Students are given classroom address books containing an list of organizations from all over the world that offer free information. These books are the starting point for further investigation of possible sources of information.

". . . the school's Language Arts teachers assists our students with special instructional materials . . ."

Before any letter is written or sent, we interject a brief review of appropriate business letter styles. Students draft sample letters which we grade for grammar, spelling and neatness. We strongly encourage our students to use a typewriter or word processor to prepare the letters they do send out.

Soon the mailing is complete and the waiting begins. You can not imagine how excited a typical eighth grader becomes when "mail call" arrives. Just one positive response to a student's letter can

generate a storm of enthusiasm to send more letters. Students soon begin to search for other organizations on their own and prepare more requests for assistance in their research.

**Field Trips**

Field trips also are another valuable strategy for inspiring students to conduct research. We are fortunate in that the Washington, D.C. area has a wealth of interesting (and convenient) locations to visit. In many instances, the technologies our students are studying are actually on display. This firsthand exposure is invaluable in generating student enthusiasm in their work and student interest is paramount to the success of the research campaign. (Remember, each of our students has selected a topic that reflects his/her personal interests.)

"Just one positive response to a student's letter can generate a storm of enthusiasm to send more letters."

**Steering the Research**

So the students don't get too far afield, we guide the research process by handing out very specific questions early in the research process. As students begin to amass information on their topics, they use these questions to weed out extraneous material. At times, there is such a large quantity of data that this winnowing process takes substantial effort. Students must select only information that appropriately addresses the guideline questions.

The following list contains a few of the questions used to guide our students in their research:

- Your invention (technology topic) helped Humankind to solve a problem in which of the following areas:
  - Defense of the country?
  - Daily life?
  - Transportation?
  - Communications?
  - How was your invention powered? What made it work? Examples:
    - Human power
    - Animal power
    - Forces of nature, e.g. wind, water, solar
    - Chemical reaction, electrical power
    - Combination of previous choices?
- Describe how your topic fits into the evolution of technology. Put your topic in the correct place on a timeline. Clearly indicate dates and previous inventions as well as inventions coming after yours.

*This seminar in progress shows a student demonstrating how much he knows about the Clermont steamship.*

*A student begins digging for answers as the research phase of the project begins.*



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*FIGURE 1*
***Examples of the Technology Topics Studied***

| TOPIC | PARTS | SCIENTIFIC CONCEPTS | MATHEMATICAL CONCEPTS |
|---|---|---|---|
| Space Shuttle | Rocket Engines<br>Wings/Tail<br>Fuselage<br>Wheels/Brakes<br>Friction | Newton's Laws of Motion<br>Bernoulli's Principle<br>Aerodynamics<br>Hydraulics | $F = M \times A$<br>Where: F = Force<br>M = Mass<br>A = Acceleration |
| Telephone | Receiver<br><br>Transmitter | Electromagnetic Induction<br>Sound Waves/Convesion of Energy<br>Diaphgram Function/Sound Waves | $I = \frac{E}{R}$<br>Where: I = Constant<br>E = Voltage<br>R = Resistance |
| Steam Engine | Boiler<br><br>Cylinder & Piston<br>Cold Water Valve<br>Beam | Kinetic Molecular Theory<br>Evaporation<br>Pressure<br>Condensation<br>Simple Machines/Work/Energy | $P = \frac{F}{A}$<br>Where: P = Pressure<br>F = Force<br>A = Area |
| Windmill | Sails<br>Gears/Shaft<br>Simple Machines<br><br>Mechanical Advantage/Work/ Force | Bernoulli's Principles<br>Wheel and Axle | $MA = \frac{OF}{IF}$<br>Where: MA = Mechanical Advantage<br>OF = Output Force |
| Bicycle | Frame<br>Pedals/Sprockets<br>Wheels | Alloy Principles/Metallurgy<br>Simple Machines/Levers<br>Wheel/Axle<br>Mechanical Advantage/Work | $W = F \times D$<br>Where: W = Work<br>F = Force<br>D = Distance |

## The Seminar

Why have we put our students through such extensive research? What will each student do with all of this new information they have acquired? Well, they are going to share it, of course!

We are now late in the school year. Each student has labored many months in the lab fabricating a detailed model of their topic. Each student has also conducted a comprehensive research campaign. Because of these two efforts, each student has become somewhat of an authority on their particular topic.

At this point, our students are untapped sources of substantial new knowledge. The only barrier hindering the release of that learning is the lack of effective communication skills.

These communications skills are acquired in a seminar during which each student also shares their recently acquired knowledge. Developing good oral communication skills is just one example of our attempts to integrate Language Arts content into our program.

Before the end of the year each student must participate in at least three classroom seminars. The seminars are formal settings with time for every student to present answers to the questions we provided earlier in their research campaign. Each seminar has a chairperson who conducts the meeting and is responsible for managing the meeting; making sure it goes smoothly and on schedule.

Each of the three seminars has a specific topic that will be addressed by each student. These topics are:

- *Function of Technology*—This seminar addresses the question of how each student's topic actually works. The relationship of the parts and the basic scientific concepts that cause the object to function.
- *Social Significance of the Topic*—This seminar addresses the questions related to the overall importance of your technology to Humankind. What has been or is the effect on our way of life?
- *Evolution of the Technology Topic*—This seminar addresses the ability of a specific technology to evolve or change. Descriptions of past, present, and future forms of a technology are presented.

In addition to preparing notes for their oral presentation, each student is required to plan and create clear, colorful visuals. These visuals enhance and strengthen their overall oral presentation. Students are given instructions showing how to prepare visuals (transparencies, slides, posters, etc.) and how to effectively use them in an oral presentation.

If each of the 20-25 students in a class addresses the broad seminar topics with moderate proficiency, we believe we've offered an effective format for our students to teach as well as to learn. The traditional roles of teacher and student have been redefined.

We, as teachers, *manage* the situation, allowing students to experience not only the task of "learning" but also accepting

*A student displays his aircraft carrier. The visual aids he developed are visible behind him. One of the reasons this student picked the aircraft carrier for his topic is that he hopes to attend the U.S. Naval Academy.*

the task of "teaching" others about their topics. Students soon discover that "teacher" does not have all the knowledge. Actually, many times we find students know more about their subjects than we do!

## Integration of Mathematics and Science

The seminar also provides a unique opportunity for the integration of math and science content into the Technology Education program. We have already discussed the significant role that the technology education laboratory can play by offering unique problem-solving situations. Actually the integration of math and science is accomplished during the research effort and the seminar merely provides the situation for directly relating specific mathematical and scientific concepts to the technology being studied.

The first seminar, "Function of Technology," provides the most direct connection for students to understand the relationship of applied math and science in the creation of a technology.

Students are asked to answer questions specifically related to function like:

- How does this thing work?
- Identify all integral parts.
- Explain how each part works or performs.
- Identify the scientific principle causing each part to perform.
- Prepare simple, clear visuals which explain each scientific principle you discuss.

Figure 1 shows several examples of the technology topics studied by students at Hanson and the scientific and mathematical principles studied in the research and explained in the seminar.

By studying specific technological developments, students are given an opportunity to understand basic scientific and mathematical concepts. Technology education is the one place in school where the student can make sense out of math and science. Suddenly vague and often meaningless principles have a purpose. Applying math and science to solve Humankind's struggle with the environment seems to make sense to young students. We have seen this in realizations like:

- "So that explains why airplanes need wings."
- "Now I know why a radio doesn't need wires or cables like telephones do."
- "You mean that a bicycle is just a bunch of simple machines all working together."

The discovery goes on and on.

## Accommodating Different Student Levels

One very important feature of our program is that it allows for individual differences in student levels. The degree of sophistication and quantity of information processed by each student variessubstantially. But we feel the ability level of a student should not diminish the value and importance of such a worthwhile program of study.

We believe that technology education is important for all students. It is the teacher's responsibility to know his/her students and manage the teaching strategies to meet the needs of each. One strong feature of this program is its focus on the individual. No matter what level a student is functioning on academically, he/she will be successful in the program if two things occur:

- The student studies a topic that is of great interest to her or him.
- The teacher manages the learning process with respect to the level of each student.

When these two criteria are met, the program has had great success. We believe that the emphasis on the individual must be maintained if truly good quality education is to be achieved.

## A Laboratory Management System That Works

A large part of our outstanding safety record as well as the overall success in our laboratory activity is due to the payroll system used at Hanson. No, not for teachers, but one we set up to encourage our students to work safely.

Each student has an account established and each week $50 is credited to it. The student simply tries to retain that amount during the five-day "work week." Students who perform safely and courteously in the classroom are rewarded by keeping all of their money. Students who make mistakes in safe behavior or conduct lose money from their account. These losses are called "payroll deductions." The four deductions and the amount charged are:

- Not following school rules in lab activities—$5
- Not following class rules in lab activities—$5

- Not wearing safety goggles in lab activities—$8
- Arriving late to class—$4 minute

We have established a grading scale based on the dollar amounts the students have left at the end of the week. In effect, money earned is placed on a weekly paycheck which the student will cash in for his or her grade in lab procedures. The weekly cash-to-grade "payout" is:

- $46—$50 earns a A
- $41—$45 earns a B
- $36—$40 earns a C
- $31—$35 earns a D
- $30 or less earn a E

Our eighth graders have responded extremely well to this payroll system. They all understand money and really look forward to receiving their paycheck every Friday (just as we do!). The system provides weekly feedback and each student can see exactly how well they have been meeting our laboratory expectations. In most instances, we have found stunents make every effort to keep their money. No matter what the age, no one enjoys a payroll deduction.

## Summary

What is Technology Education at John Hanson Middle School? It's a program that is focused on the individual. It is an attempt to blend young persons developmental stage with a relevant study of our industrial/technical society. It is a program that offers:

- Active learning
- Students *doing* things
- Young people sharing discoveries
- Students teaching each other

Our program provides students the opportunity to actively share in their learning experience: it's not just an experience that is teacher-directed and teacher-controlled. It is a program that also presents a realistic and workable integration of subject matter. Science, mathematics, language and social studies actually begin to mean something to the student.

If managed properly this type of program can be the one place in the school where students can appreciate the importance of studying their academic content areas. It just seems to make sense to them. We feel our program is an example of a meaningful and relevant study of technology. The topics studied by our students are all solid examples of either a contemporary or anthropological technology that has significantly changed the way we live.

# Technology Programs

# Greece, New York

**Glenn Listar and Paul Schiffman**

Greece Athena Junior High School has been involved in offering technology education to both seventh and eighth grade students for the past two years. We continue to be a pilot center for New York State in introducing the new curriculum for students under the talked about Regents' Action Plan. Each week during this period, brought us visits from teachers and administrators from throughout the country who came to watch and find out what is going on in our classes. They are particularly interested in seeing how we are implementing the new program, as well as looking at ways to develop a "teacher comfort" factor in changing over to the new state syllabus.

Athena Junior High School consists of approximately 1,000 students in grades seven and eight. Greece, N.Y., is a bedroom community outside of Rochester, which is the home of Eastman Kodak Corporation as well as to many other large technically-oriented companies. Our students come from all different types of social and economic backgrounds; however, we classify ourselves as a typical suburban educational setting.

Since the opening of Athena Junior High School, approximately 17 years ago, industrial arts education has been a required course for all students. We continue to offer technology education to all of our students regardless of educational classification, sex, or handicapping conditions.

Formerly, we used a four-cluster approach:

- Construction
- Graphic Communication
- Power/Energy
- Manufacturing

During the summer of 1984, veteran staff members began a training program to prepare them to teach the new technology syllabus. Staff experience ranged from a first year teacher to veterans with over 25 years in public education. All staff members participated in workshops for both the seventh and eight grade programs provided by the New York State Regional Technology teacher trainers.

Each teacher has now spent a minimum of 120 hours in training. During these workshops, not only did the teacher get a chance to experience activities in each of the modules, but they also were encouraged to look at the objectives and concepts of each module and develop activities they could use in their classroom. This type of training eased the transition from teaching the traditional industrial arts instruction to teaching the new technology program.

During the training we were very apprehensive about teaching the new program for we felt we were being pushed

***Display bulletin boards in the laboratory stimulate students' interest in the program.***

*Glenn Listar is a Technology Education teacher at Greece Athena Junior High School and Regional Technology Teacher Trainer. Paul Schiffman is Vice Principal at Greece Athena Junior High School and Regional Trainter for implementation of the Regents Action Plan.*



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into a course we were not prepared to offer to students. We also felt that our present course was superior and would best meet the needs of our students. However, when offered the opportunity to pre-pilot the program, we volunteered to take part. It was our belief that we would be the best educated critics of technology education.

"We were very apprehensive about teaching the new program . . ."

Now, after implementing the technology program for the past two years, the staff members look at the past four cluster program as a good experience for young people—but the technology program far surpasses what we could have ever expected. After the pre-pilot experience, all of our staff moved from critics to advocates for technology education.

We were so impressed with the quality of this program, that we implemented full instruction for all students two years prior to the State's mandate of September 1986. By running the pre-pilot program for the seventh grade during the 1984-85 school year, Greece teachers gained experience in implementing the program and had an opportunity to try various activities to meet the objectives and concepts of each module.

"We felt our present course was superior."

Greece Central Schools follow the New York State curriculum for technology education as written in 1984. Seventh and eighth grade students take technology education for a 80-minute period every other day for 20 weeks.

In teaching the new curriculum, we try to follow our own in-house rule of 20% teacher-directed instruction and 80% hands-on activities. We firmly believe that this is the only way to offer a junior high school-aged student the technology education program. Good teaching creates a learning situation that devotes as many minutes as possible on students participating in the learning process.

Using this activity-based approach enhances the technology education for our students as well as increasing the rate of retention for students. We feel students *like* our courses as well.

The New York State Junior High Technology Program consists of ten modules with a mandate that students, by the completion of eighth grade, will have 40 weeks of technology education. Each of these ten modules has its own concepts and objectives. New York State teachers are to develop and use TLA's (Technology Learning Activities) to meet each module's concepts and objectives.

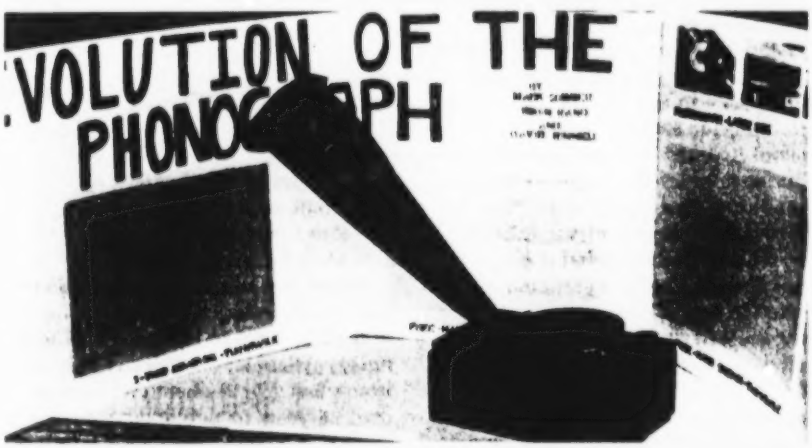
The TLA's are activity sheets that inform:

- What module the TLA is written for.
- The objective and concepts the activity covers.
- An overview the activity.
- Student/teacher activities by class period.
- Constants that are infused in the activity.
- An evaluation plan for student and the TLA, itself.

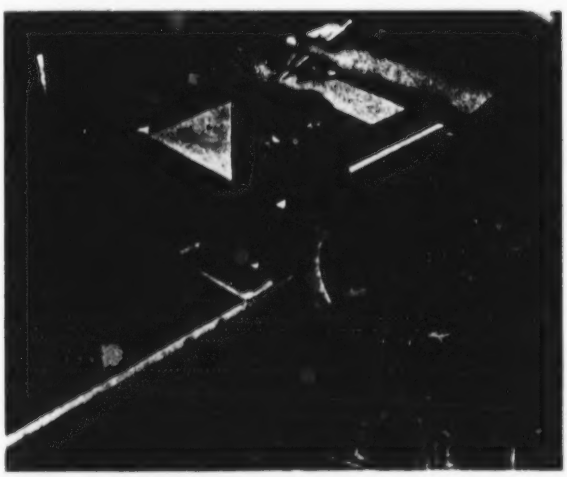
In Greece, the junior high school teachers selected and developed a series of TLA's to use to meet each module's requirements. As mentioned, our activities incorporate at least 80% hands-on experience.

Greece teacher have developed unique activities which have given rise to an exciting program for the students and for the instructors.

Some of these unique activities that have given rise to excitement in Greece




***Student's evolution activity showing how technology has improved the quality of phonographs over the years.***



***Student using one of the technology processes to meet the objective of the module.***



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are in Module T-1, "Getting to Know Technology." In this module, students use their technology process *skills* to show and explain how technology has created the world as it is today. The TLA on the evolution of technology has the students do research on a device of their choosing to show how that device has changed since its inception due to technology.

Technology process skills are skills that relate to one of these five technology processes:

- Layout and measurement
- Cutting and machinery
- Forming and molding
- Fastening
- Coating and finishing

All of the TLA's used in Greece require students to develop their skills in the technology processes to meet the goals.

In the next module, T-2 "Resources Needed for Technology," a series of activities helps students explore and get to know the seven resources:

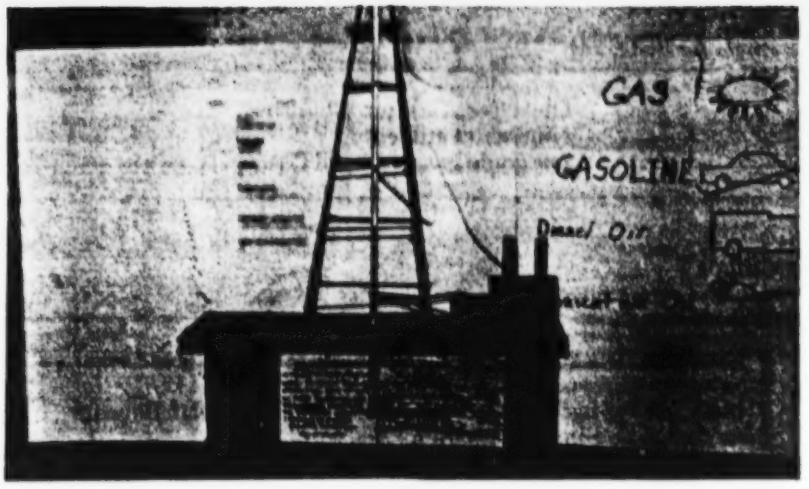
- Time
- Time and machines
- Knowledge
- Materials
- Energy
- People
- Capital

One activity requires the design and building of a model of an energy source. The photo above shows a student model of an oil rig. The student explained how we refine oil as well as where and how we have used this energy source in the past and present and how we might in the future.

"Students rent tools and machines to be used in their task."

Today, the Greece teachers have approximately 22 problems and statements to choose from in Module T-3, "Using Technology to Solve Problems." Part of the activity's process in this module is for the students to explain to the class their solution to one of the problem-solving activities.

For example, of the activities on the current list calls for the student to design and build a musical instrument of their choosing. Then the student must plan one line of a given song with the instrument they construct.




***Student-completed module of an oil rig.***

To complete their task in this module, students are given a specific amount of various supplies to work with. Bogus "Technology Money" is one of these supplies. This "money" allows students to purchase other supplies and to rent tools and machines to be used in their task.

Students need to learn that there is a cost for resources. Prior to this module, students take classroom tools for granted. Now, each time a screwdriver is used, there is a charge, for it has depreciated in value. Students also learn that all projects have budget limitations which could effect the success or failure of great ideas. With the bogus "Technology Money," the students keep a daily budget and plan out a process and the costs needed to complete their assigned task.

In "Systems and Subsystems," Module T-4, students are required to design and build a system of their choice using technology processes. In this system, the sub-system must be identified and identification of this device in a open or closed loop systems diagram.

These are a few of the activities that enable students to use their thinking power and skills to solve the various tasks of each of the TLA's in the Greece Central School District.

The Technology Learning Activity (TLA) for Greece Central gives the teacher a foundation and justification for ordering supplies and equipment needed to fulfill the technology program. Just as students use resources to complete their

***One student presents their solution to a problem-solving activity in the fourth module.***

***Another student has a different solution to the same problem-solving activity.***

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***FIGURE 1***
***Formula for Budgeting***

Objectives/Cost per Objective/
Number of students
per grade level = Total Cost

***FIGURE 2***
***Examples of the Transfer of Skills***

- Language Arts skills in public speaking and writing the required informational reports.
- Math use for budget-related activities and the calculations for their design and implementation.

tasks, we, as teachers, need to follow the same guidelines.

Our budget system is a simple one. We ask three questions:

- What objectives do I need to cover?
- What resources do I need to meet this objective?
- What is the cost of the materials?

This information is gathered at budget time and submitted with the final supplies list. Our formula for budgeting is shown in Figure 1. It has been our experience to receive all of our budget requests.

Traditional woods, plastics, metals and graphics facilities no longer exist in our school. But our facilities are not the "utopia" you might envision are needed for a quality educational program. (One of them reminds us of a submarine.)

But still we have created facilities that meet the needs of our program. We believe that we are now running safer facilities than we have in the past. It should also be noted that the cost of converting our facilities was done at minimal expense. We also believe that the conversion costs are running at a lower rate than anticipated materials.

"Our facilities were not utopia, one of our rooms reminds us of a submarine."

At Greece Central, we are very fortunate to have a supportive Instructional Office, superintendent, Board of Education and community advisory group. Over the past two years we have made two presentations to the Board of Education and another to the community advisory group. At all of these meetings, we left with a vote of confidence and a promise that we would find financing as well as other types of support in helping to meet the goals of technology education for adolescent students.

Members of our Board of Education have paid visits to our labs and spoken with students. Over the course of these past two years, Greece Central School District has received recognition as an outstanding technology education program as well as receiving national recognition for the same.

Our students' work has also received awards for outstanding accomplishment. Athena Junior High School believes that students not only learn in the classroom, but also learn from out-of-school activities. Over the past few years we have developed a Science-Technology Club. This club is run in conjunction with our school's Science Department.

We tell our students that there is a transfer of learning between the sciences and technology, as well as to other areas. This transfer of experience from the technology activities to other subjects is briefly illustrated in Figure 2.

Technology education at Athena Junior High School receives the same weighing as any of our core academic subjects. All students are responsible for *writing* a full hour technology final examination. This examination counts for 20% of the student's grade and is recorded on their report card.

Athena Junior High School students receive what we believe to be an outstanding education in technology. They learn the basic components of technology and are taught in a meaningful setting which gives students an opportunity to explore while learning.

We believe our students are prepared to continue on in the traditional industrial arts or to further other purists in their education with technology. If a student decides not to go through a vocational program, we feel that they are better equipped to handle the technical components of mathematics or the sciences or to be prepared to face the many challenges that career opportunities will offer.

As we look back over the years when we were not offering technology education, we have no regrets or remorse for what we were doing. For at that time, we were teaching the four cluster program which was the best program we knew at that time. We now know we can offer our students something better and something that will help them in the years to come.

"Technology education receives the same weighting as any core academic subject."

Technology education is a program for which we are proud. The Technology Program is one which sells itself. The students' excitement and knowledge has given us the community support for our continued growth and strength in this every changing area.

# Technology Programs

# Troy, Illinois

**Dale Gerstenecker, Robert Daiber, Michael Moore and Richard Conley**

The "Triad Technology Education Cluster" was established in 1980 as an innovative technology education curriculum. The philosophy behind labeling the curriculum a "cluster" was to organize the courses in a format so students could learn about different areas of technology and understand how they relate to each other. The cluster was designed so students could learn about different areas of technology by scheduling various courses. The cluster format allowed for cooperative faculty efforts to conduct projects that interrelate the different course disciplines toward a common project.

Initial development of this technology program was pioneered by the Triad staff. We created a list of general objectives which provided the goals of the program. Then the curriculum was developed based on these objectives, rather than modeling it after other programs or a state plan. Since the original curriculum development, the only revisionshave been minor changes to remain relevant and to mesh with the "Illinois Plan for Industrial Education," that was subsequently developed by the state. The program today follows the same basic curriculum as originally established, and the original list of objectives are appropriate for today's "Triad Technology Education Cluster" (TECC).

*The authors are all teachers in the Technology Education Cluster at Triad High School.*

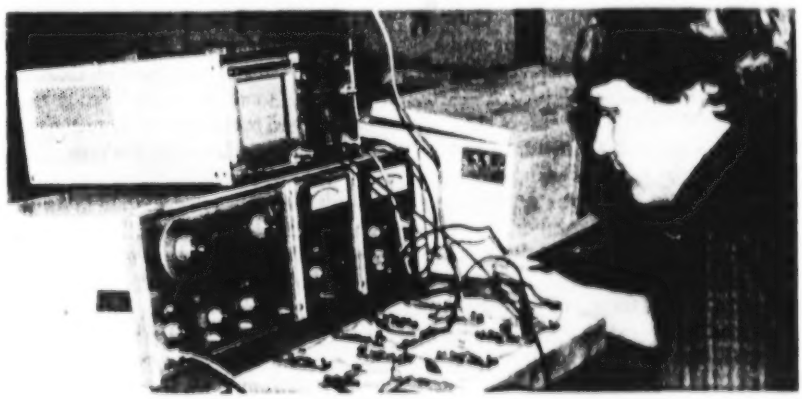
## The School and Community

The TTEC program serves the students of Triad High School, grades 9 through 12. Total school enrollment is around 800. The school is the only one in Triad Unit District No. 2, which includes grade schools in the communities of Marine, St. Jacob, and Troy, Ill. The district is somewhat rural but borders the St. Louis metropolitan area, and many residents rely on the metropolitan area for a broad spectrum of employment.

## Goals of the Program

The following objectives were devised by the Triad staff to develop the curriculum and are the basis of the current program:

- Provide an introduction and exploration in the areas of technology to illustrate how people use information, tools, materials, processes, and energy to satisfy their needs and wants.
- Develop sound technical skills which will prepare students to enter a vocational or technical school, college or employment after graduation.
- Group the content areas in a cluster to illustrate how drafting, electronics, and production interrelate in a system.
- Diversify students' skills in the major contents of technology (production, energy, utilization/transportation, and communication).
- Generate group activities in which students will learn to think and work together.
- Better equip students with skills and abilities to seek jobs which will develop in the future.
- Aid in the overall educational experience of students to enable them



***A student in Electronics II uses an oscilloscope to measure the gain of a transistor amplifier.***

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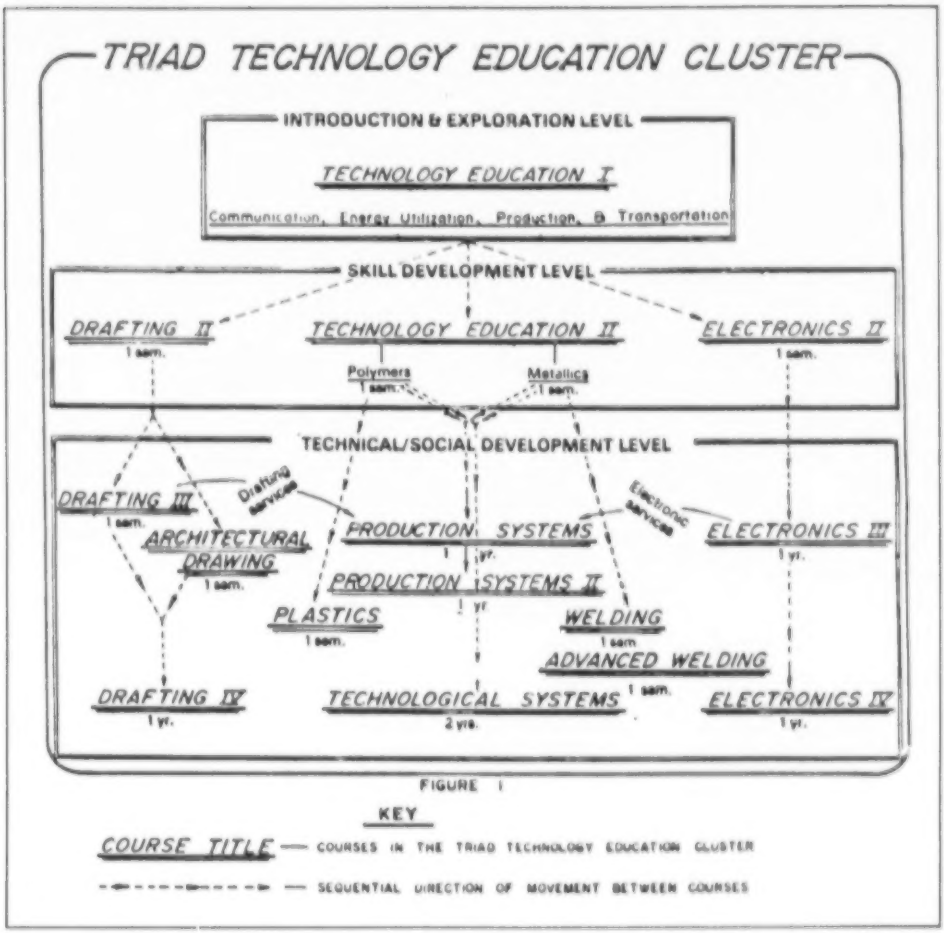


FIGURE 1

***FIGURE 1***
***This schematic depicts the structure of the Triad technology education curriculum.***

to better cope with cultural change caused by technological advancement.

- Remain relevant to the growth and development of technology by eliminating and adding new subject materials.

## How Program is Conducted

Different sections of the course offerings are taught by four teachers. Courses are offered on an elective basis and are divided into three different levels of study on a sequential basis:

*Level 1*—The student enters the program by taking a course to introduce and explore the various technological areas;

*Level 2*—The student can then continue to develop his or her skills by choosing from various skill development courses; and

*Level 3*—The student may study more advanced technical studies of technology in the technical/social development level.

Figure 1 illustrates the courses, levels, and sequential paths that may be followed within the program. A student enters at the top level and continues in any of the sequential directions down into the skill development and social/technical development levels.

The introduction and exploration level is one course: "Technology Education I." This is taught by all four teachers, each focusing on a different area. Students study communication and energy utilization one semester and production and transportation during the other.

The courses on the skill development level are semester courses in drafting, polymers, metallics, or electronics. Each are designed to develop more individual skills and knowledge in the area.

At the technical/social development level the courses are designed to further develop the technical skills of the student as well as social skills and understanding to enable the students to deal with technology and its implications. The courses on this level give a student the opportunity to obtain practical experiences with modern technology.

A key element in TTEC is flexibility—the program's continued ability to incorporate up-to-date curriculum materials. The change process works like this: Instructors research and identify technological developments, issues, and trends which may benefit the students' technology education. At departmental meetings, new subject matter is discussed and organized as part of course outlines. Decisions are also made on any content to should be deleted.

So we are continually adding new technology research, and deleting the old to maintain an appropriate education. Thus, we continually renew our program without major changes to the entire program, which could cause problems in scheduling, administrative acceptance, and continuity for students in the program.

An example of this flexibility is a change that took place in the course "Technology Education." The suggested content of the Illinois Industrial Education Plan was evaluated and discussed by the staff and we found we

*Students work in small groups constructing miniature greenhouses to learn about passive solar energy principles.*

*A Drafting II student generates a basic drawing with CAD system.*

*The Level II Metallics Competencies pictured show that traditional hands-on activities can still occur in a technology-based program.*

considered it more appropriate than the what we were using. So we adopted it. This change was implemented without changing the course title or the whole program. Another example, on a smaller scale, was the revision of the drafting courses' contents to include computer-aided drafting. The course offering did not change, but the content remained up-to-date.

## Interdisciplinary Appeal

An effort is made by all technology instructors to interface other disciplines with our classes. Class units that involve activities and lessons relating to history, current events, geography, math, science, or literature are commonplace. These units are included to illustrate the true relationship between people and technology, and the world in which we live.

We feel this interrelationship is an important part of technology education and this instruction is provided to fully augment the students' technological literacy. Naturally, not every class interfaces with each of the subject areas mentioned. The following examples illustrate how the technology classes interface.

- A transportation course may involve a historical study of the development of transportation systems. As an activity, small groups of students work together to construct a time line.
- Students enrolled in the skill development course, "Metallics," learn about the U.S. geographical locations where iron ore deposits are located.
- A major focus for the courses "Production" and "Technological Systems" is current events. Both courses are concerned with technological changes that result from socio-economic, political, and technical developments.

A special unit is taught in the technological systems course the third quarter of the 1985-86 school year that emphasized the interface with math, science, and social studies. Small groups of students worked together to: 1) select a topic for research; 2) build a working model of their technology topic; 3) discover and research the relationship of math, science and social studies to technology; and 4) compile a formal technical report for presentation to the class.

To complete this assignment, students discussed their topics with teachers in the respective areas of study, wrote manufacturers to secure technical information, combed school and public library materials, and applied the scientific method to conduct the research project. The technology research projects included a wind tunnel, bicycle, laser, magnetic motor, and electric soap dispenser. Figure 2 shows the students' research results.

## Student Activities

A variety of activities within TTEC

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involve not only classroom and laboratory learning experiences but contest and special interest sessions sponsored by corporations, professional associations, or institutions of higher education. Throughout the program, activities establish students' technical and social-cultural skills. Many technology activities are a realistic portrayal of the world today, because the activities deal with problem-solving and decision-making tasks.

Instructional units are organized in a meaningful manner in that the hands-on activities are an outgrowth of classroom technology lessons. In some instances, lab activities involve as much thinking as physical work.

Department members have observed the technology classroom activities's development of students' understanding of tools, materials, and processes. Students seem to have a better grasp of the concepts and principles governing the use of hand tools, power equipment, and machines as students in a more traditional program.

The activities in introductory classes are naturally less complex than activities in higher level classes. Examples of activities experienced by students are provided in the following explanations. These descriptions are listed according to program levels.

## Introductory and Exploratory Level

*Activities at this level provide students with a general awareness of technology. Students learn the safe use of tools, materials, and processes related to drafting, electronics, metal, and wood through many different hands-on projects.*

### Solar Energy as an Alternative

After the students have studied sources of energy, they study solar energy as an alternative energy source by researching and developing miniature solar greenhouses. Within given limitations the students design and construct small greenhouses, then test how well they've done by checking the temperature inside, when oriented to the sun.

### Paper airplane contest

Each quarter transportation students participate in a paper airplane flying contest. Students learn about basic flight principles. The airplanes are geometrically designed on 8½" × 11" white bond paper. The students fold the paper and assemble component parts such as paper clips or staples. This activity takes place over two class days. The current record is 66'11".

### The Enterprise

This activity is a partnership formed for a two-week period at the end of each semester. The partnership is a team-taught activity between the transportation and production classes. Students are grouped into various manufacturing areas such as Personnel, Research and Development, Quality Assurance, Transportation, Time and Motion, and Marketing. After several assigned activities the activity culminates with a two or three-day production run.

## Skill Development Level

*Activities at this level advance students' technical skills through competency-based learning. Students are presented with conceptual learning activity units to become more competent in measuring, cutting, fastening, finishing, etc. These activities provide the necessary skills for students to construct technology-based projects at the capstone level. Related activities at this level further students' understanding of the relationship between people and their use of tools, materials, processes, energy and information.*

### Electronics Activity

In Electronics II, classes work with discrete components up through various types of semi-conductors. Breadboarding is used so that students learn to construct circuits from schematics. Testing equipment is employed to teach the characteristics of many types of circuits. These hands-on activities augment the classroom lectures and discussions.

### Computer-aided Drafting

In drafting courses, assignments are completed mechanically but students also learn about computer-aided drafting. The Drafting II students are oriented to CAD and complete a series of tasks to generate a basic drawing with a CAD system. Higher level tasks are completed by students in the Drafting III, IV, and Architectural Drawings courses.

### Metallics II Lab

At this level the students' skill development centers around competency-based lab activities. Students rotate through 24 work stations to learn and develop numerous skills necessary to become safe and knowledgeable workers.

### Polymer Projects

In the polymers classes, the projects are designed to develop skills and knowledge in basic machining and processing. Most projects involve wood but as the class content also introduces the

55

***In Level one production students research and develop Yo-yos.***



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student to plastic materials, it is labeled polymers.

## Technical Social Development Level

*Activities at this level help students realize the impact technology has on their lives and understand how to cope with technological change. Students are actively involved in multiple technical and social/cultural learning activities. These activities provide capstone experiences for students in that they have the opportunity to gain practical experience with new technology.*

### Digital Electronics

Students in Electronics III and IV study digital logic circuits up to and including micro-processors. Many circuits are breadboarded so that students can learn testing procedures and troubleshooting techniques.

### Applied Drafting

In this assignment, pupils are develop technical drawings for actual products. Students apply methods of drafting and learn many problem-solving lessons. When possible, the assignments are for drawings to be used in other classes of the cluster.

### Mass-Production

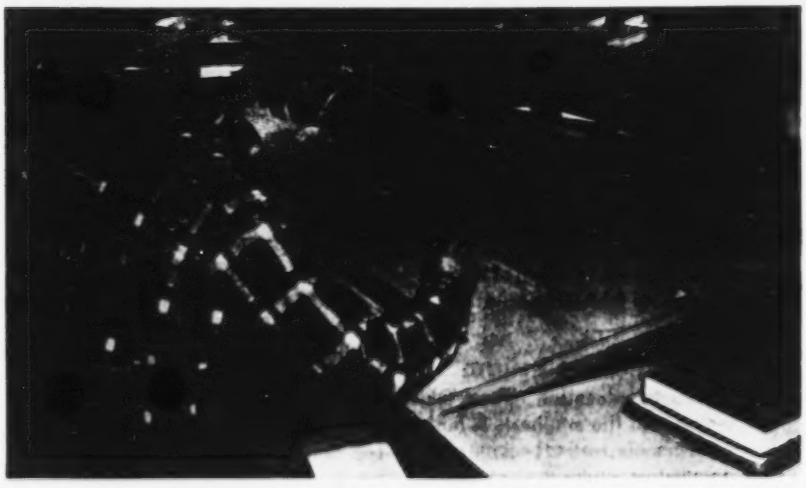
The culminating activity for students enrolled in Production Systems is to mass produce a product. This activity closely simulates real manufacturing experience. Students organize a company, sell stock, and attempt to realize a profit from their product. A percent of any profits is donated to a charitable organization. This illustrates to students the social responsibility a company has in a community. The remaining profit is deposited in the Technology Education Association Fund. This fund is used to finance student activities such as field trips.

### Robotics

The building of small-scale robots increases the technical skills of students in the advanced course, "Technological Systems." Students acquire knowledge of mechanical, electromechanical, and automated principles. The robotics activity includes design, construction, and computer controls. A programmable controller is used to interface the robots with conveyors to perform pick-and-place tasks.

### Productions II

This newly-developed class is an in-depth study of manufacturing. The central activity is a joint venture with area businesses to design and/or produce products or production devices. The two semesters that this course has been offered, students have manufactured cedar siding for a local lumber company and keying station stands for an automated sortation system for companies in Texas and Tennessee.



***Students in Drafting III and IV make working drawings for products designed and produced in production classes.***

## Support Groups

A unique feature of TTEC is that it was been developed, implemented, and revised by the department instructors. Unlike other exemplary programs, the Triad curriculum was not a pilot project created by a state department or university research staff. For this reason, we feel the curriculum is a very practical approach to technology studies in secondary schools. All changes are tested on a trial basis, before the department members make the final decision on revision.

But this doesn't mean that we are devoid of outside influence. Indeed, outside resources, to some extent, have influenced the present program. These include local business and industry, the Illinois Plan for Industrial Education project staff, and the State Department of Adult, Vocational, and Technical Education. These resources have provided ideas that have improved the program's structure and content.

Our greatest support group has been our students. The success and the accomplishments made within the department have been due to our students' dedication. Technology education has provided various previously unexplored directions for students to pursue upon graduation. Both the students and their parents realize the program's significance as part of the total school curriculum and support it.

Much support has also been come from the school's superintendent, principal, and vocational director. The administration has supported curriculum changes made by the department and viewed the revisions as a contribution to the total school curriculum. They have also supported the instructors by allowing then time to attend in-service meetings at local, state, and national conferences.

## Conclusions

In recent years, many reports have been publicized nationwide calling for needed reforms in education. It is odd that the reports many of the needed changes cited by the reports already addressed in technology education. Yet most reports do not recognize that technology education exists—let alone is part of any solution. TTEC is not a total solution, but programs like this are needed to provide today's students with an appropriate education.

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# Technology Programs

# Conroe, Texas

**Larry J. McHaney and Jerry Bernhardt**

A simple discovery caused some radical changes and opened incredible new doors for technology education at McCullough High School. The school's first academic pep rally; visits from and discussions with Congressmen, Senators, state officials, astronauts, influential community leaders, dignitaries, newspapers and television reporters; students excited about schools; and increased enrollment for next year represent only a few of the effects felt so far. What we discovered was how to unleash the potential of Technology Education through what we call the "Central Project" and "Component Project."

In recent years a great number of people have cried out for some type of educational reform. A wide range of theories have emerged, but few people have found a way to effectively put these theories into practice in the classroom. At the same time, the change from Industrial Arts to Technology Education has left many teachers asking, "do I implement the new curriculum? What effect will these new educational theories have on Technology Education? and our jobs?

In an attempt to increase the academic nature of courses and implement Technology Education, some schools have discarded much or all of their traditional equipment and spent thousands, even millions, of dollars to purchase new "high tech" equipment for their programs. However, most of us work in school district which cannot afford to invest that amount of money on our programs. So how can the rest of us truly teach technology and till survive the trend toward an "intellectual" focus in education?

We at McCullough High School feel that we have found a way. We realized that Technology Education requires a change in philosophy more than a change of equipment. This article attempts to show teachers how the "central project" is a practical model which can be used to modify existing curriculum content for implementing Technology Education, while, at the same time, incorporating many of the theories and accomplishing many of the goals set by some of the best known leaders in education reform.

"We realized that Technology Education requiries a change in philosophy more than a change of equipment."

*The authors are both technology teachers at McCullough High School, Conroe, Tex.*

## Trends in Education Reform

The trends in education reform take many shapes, but the emphasis is fairly consistent. Schools need to become intellectual incubators where students "learn how to learn and thus to teach themselves" (Sizer, 1986). According to Adler, students need the ability to learn to help them grow mentally, morally, and spiritually; to become good citizens and to earn a living (1982, pp. 16–17). Our fast changing world has created a huge, ever growing, ever changing knowledge base. So that even if schools could afford to constantly update their equipment and stay on the cutting edge of technology, they still could not prepare students for the dynamic and unpredictable job market of tomorrow. High school can no longer attempt to be comprehensive (Sizer, 1986) and provide students with all of the knowledge they need to live productive lives. Students must leave high school equipper with the ability and desire to become life-long learners.

## The Role of Technology Education

Even though other departments in the school could direct the central project, we feel that the most logical and best suited department for the job is Technology Education. Technology is the practical application of science, math and language to improve the qualify of life. Technology had and continues to affect our history, our society, our political structure, our health and almost every part of our lives.

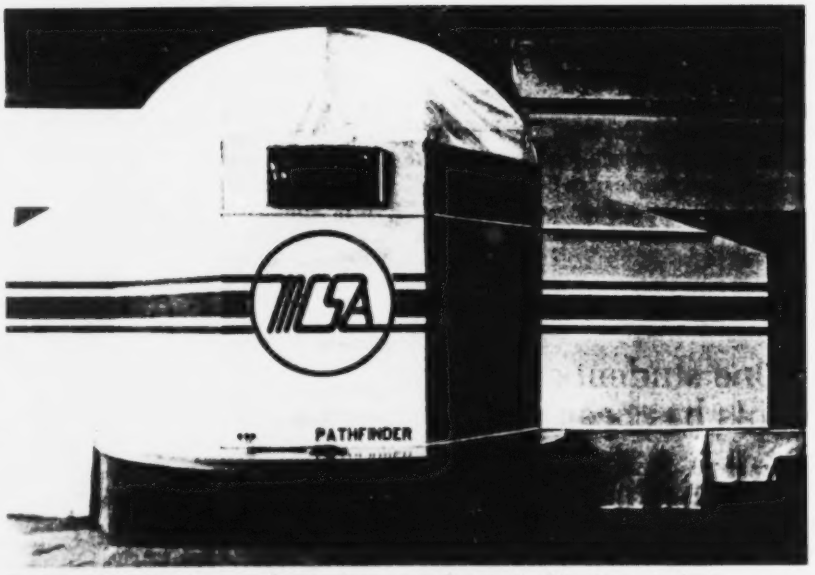
Many of the proponents of education reform understand the profound impact of technology on our world and many think that all students need to learn about technology (Boyer, 1983, pp. 109–111). Technology education courses should allow the practical application of all subject matter. A well planned central project provides one of the best ways to make technology education a vital part of a

school which helps students to learn how to learn.

## What is a Central Project?

The idea of a central project is not new, in fact it is quite old. Frank White quotes Edgar Mitchell's Institute of Noetic Sciences to point out several historical central projects including the Egyptian pyramids, Gothic cathedrals and, more recently, NASA's Apollo project. He goes on to say that central projects are a "means of focusing the energies of a population during an evolutionary transition to a higher level of culture" (1987). In schools, a central project is a topic around which students, teachers, administrators and the community as a team focus their energies.

Teacher can plan a portion of their curriculum to correspond with the central project theme and guide students toward the development of at least part of the project. All of education can benefit by understanding their relationship to a school-wide central project (Figure 1).




***Project Space Station was born when second-year Architecture students wanted to try something different and eventually grew to include over 400 students. The finished station awaits its "astronauts" and their three-day mission.***

## What is a Component Project?

All forms of business and industry are actually orchestrations of component projects which are brought together to form a central project which they hope will be a salable project. Much like industrial projects, central projects are usually too large and too intricate for any one person or class to complete, and must be broken down into smaller individual or group projects that we call "component projects." Many component projects can be divided again into subcomponents. Students learn the difficulties of coordinating, communicating and consolidating their efforts in a complex organization.

## McCullough's Central Project Project Space Station

The project started when second year Architecture students, tired of drawing typical residential and commercial buildings, wanted to try something different. Given the problem description, students works enthusiastically to research, design and build a habitat which would sustain four people in an outer space simulation for 72 hours then carry out the three-day missions, wrapping it up with a final evaluation of the project. Thus was born Project Space Station.

A few days later, the second-year Technical Drawing students asked how they could get involved. The Space Station needed an Orbital Maneuvering Vehicle (OMV) with mechanical or robotic arms to launch satellites and do repairs so the Technical Drafting class assumed the responsibility of designing and building it. They began to work with the Metal Technology students who helped to develop and produce components for the OMV and its arms. Wood Technology students development and produced containers to hold experiments, food and clothing. They also produced plaques that we gave to our major contributors.

Almost every student enrolled in a Technology course got involved in the project. Figure 2 shows some of the component projects that made up Project Space Station and how they relate to our new Technology Education curriculum.

We found that students learn, "under the right conditions, not only to accept but to seek responsibility" (Peters & Waterman, 1982) when students who had never taken a technology course came to us asking how they could get involved.

As the project continues to grow, we began to realize that not only could students from other courses get involved, but we saw how much we needed the talents of these students and teachers. We had help from students and teachers representing almost every group in the school. In all about 400 students worked on the many components of the Space Station. We started the McCullough Students Astronauts club (McCSA) to help consolidate the great variety of students.

Some departments integrated the project into their curriculum be developing, submitting and monitoring experiments which the crew performed during the mission. The food services classes research space food and then precooked and packaged all the meals for the astronauts. The Art Department decorated the commons area with creative space art. The math classes helped with water volume, air replacement and weight calculations and also prepared an experiment determining astronauts response time that was performed during the actual mission. Physics classes helped build robotic arms, language arts students prepared the astronauts for all of the writing that would be required, and the social studies classes took an active part in soliciting support and participation from local, state and national elected officials.

Individuals and companies in the community pitched in to support the project. Some donated money, materials or discounts on needed items. Others gave their time and expertise which lead to professional mentorships and, even, job opportunities for some students.

One mentor was a doctor who worked for NASA during the Apollo missions. He read about our project in the *Houston Chronicle* and called us. He invited a couple of technology education students and a couple medical careers club students (who were developing a medical experiment for the mission) to come to his laboratory at the University of Health

Science Center so he could show them the proper way to conduct the experiment. The space station was set up and the mission carried out on the stage in the commons area of the school for everyone to see. At the blast-off celebration (pep rally), the whole school and many families and people from the community packed the gymnasium as the McCSA students entered like the football team and set in the seats of honor. Congressman Joe Barton and Astronaut Joe Allen encouraged and praised the students, the school and the community for their vision to attempt such a project and their perseverance to complete it.

"One student said, 'This has been the neatest experience I've ever had in school.' "

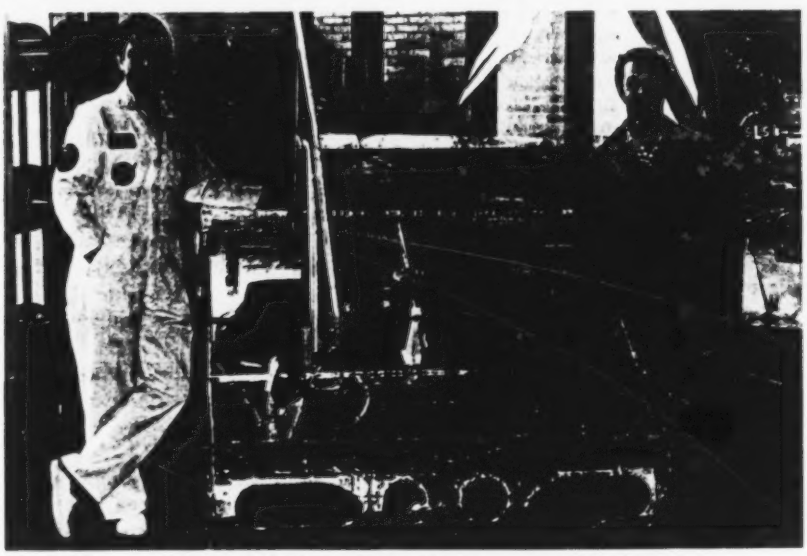
The first night of the mission we held a Space Station extravaganza to give more people in the community a chance to the see the mission in progress. The school jazz band and choir performed to open the event. Later, Senator Phil Gramm called from Washington; John Trebes, director of the space station mock-up facilities and Dr. Larry Bell, president and founder of the Sasakawa International Center for Space Architecture at the University of Houston spoke to the audience of 1,200. The crew performed experiments as the crowd watched by video camera and then launched a satellite (a helium balloon) with a peace message especially written for the occasion by elementary school children.

The mission was a great success because of the hard work and cooperation of all of the students and teachers in the school, a tolerant and progressive administration and tremendous community support. Each student involved came away with the educational experience of a lifetime. As one of our astronauts put it, "this has been the neatest experience I've ever had in school."

## Criteria for a Successful Central Project

An idea for a central project, in order to be successful, should meet certain criteria:

- Stimulate interest
- Incorporate the community and its available resources
- Be meaningful and realistic
- Be interdisciplinary
- Be made up of component projects
- Encourage creativity
- Provide recognition in the school and community



***The authors pose with the OMV—Orbital Maneuvering Vehicle, also researched and built as part of the central project.***

### Stimulate Interest

A recent survey of workers in America asked them to rank, in order of importance, the ten aspects of their jobs that keep them motivated. Surprisingly, "interesting work" topped the list (Kovach, 1987). Students in America, like the workers in the survey tire of being taught the same old thing in the same old way. They complain that school is boring and worthless. Thus, Thomas McDaniel (1985) made his first commandment of student motivation, "Thou shalt build an interesting curriculum," to insure the central project's success, it must capture the imagination and interest of students, faculty, administration and the community.

At McCullough High School, we chose a space-related project because we felt that in our community it would be the best topic to stimulate the interest required.

Not unlike young people of the early 1800's who dreamed about the Western frontier, a great number of today's student are fascinated with and drawn to their frontier: Space. With the achievement of their century in mind today's students know that they will be the engineers, architects, designers, scientists and technicians of the 21st century—a century that will no doubt see the exploration and colonization of many parts of our solar system. Astronauts are still thought of as heroes in America and the space program continues to be looked upon with awe by the general public; therefore we feel that programs which deal with space will generate a great deal of excitement among students, faculty administration and civic leaders in almost any community.

### Incorporate the Community and its Available Resources

The future of our country and our way of life depends on the quality of education our student receive (Alder, 1982). Therefore, business, community and educational leaders need to realize their interdependence and work together to make education the responsibility of the entire community, not just a handful of paid professionals. Too often, schools become isolated entities and self-contained communities (McDonald, 1986). The importance of community involvement in schools is well documented. "The growing thriving partnership between public education and the private sector," says Carolyn Warner, "is the most important partnership in America" (Teacher & Instructor, 1986). These partnerships help students fell like a part of

the community (Boyer, 1985) while providing the school greating access to technical, financial and political support (Wilson & Rossman, 1986). A good central project can help build lasting partnerships for the school and establish mentorships between professionals in the community and students.

As discussed earlier, space projects appeal to all types of people. Bring located just north of Houston, the Woodlands and McCullough High School are close enough to make use of the Johnson Space Center as a resource for information and field trips. Our project was well timed to elicit great community support because at this time there is also much hope that the development of NASA's Space Station will help revive Houston's economy.

During the course of the project, many professionals, including doctors, engineers, architects, university professors, video experts and more gave their time, energies, equipment expertise, and sometimes money to help our student succeed.

Businesses in the community helped by provided supplies and materials free of charge or at tremendous discounts. Research shows that people who are involved with schools "perceive them more favorable" (Wilson & Rossman, 1986). Those involved in Project Space Station think highly of McCullough High School. Other schools may be located in areas in which other topics for central projects may be more applicable or generate more interest and participation than space projects. Consider the needs, interests and resources of the community, then choose a project which is best suited for your students and your community.

**Meaningful and Realistic**

Another key factor is that the project not only be studied and designed on paper, but it must be used and tested for the whole school and community to see. "All genuine learning is active, not passive" (Adler, p. 50), therefore, the motto for Project Space Station was: "I hear and I forget, I see and I remember, I do and I understand."

Students want to see that their work in school is not in vain. Students always ask, "Why are we learning this? How will it ever be of any use to me?" The central project answers those questions. A creative teacher can in some way, link almost every assignment to the central project or a component project.

Students then see how what they are learning relates to the "real world." The project itself, the work that is done and the way in which it is done, creates a learning environment which is very similar to industrial practices.

**Interdisciplinary**

As discussed earlier, central projects can and should involve the whole school.

"Student questions should be answered with probing questions or one of our favorite responses 'I don't know. What have you found?'"

The central project model provides students with the missing step in the education process by giving them the rare opportunity to synthesize and apply a vast array of knowledge from different disciplines throughout their educational careers into significant and meaningful practical applications. Students learn how different subjects within the school relate to and depend on each other. Interdisciplinary design teams can be formed which will allow students to learn from each other as they work together and pool their knowledge to solve design problems. To get other teachers involved, the project directors should point out the great number of positive aspects of the central project and help them understand how the project relates to their field. The expertise of teachers and students from other departments may be critical to some central projects.

Sizer, Adler, Boyer and many others believe that the strict departmentalization of the high school must be done away with to help students understand the interconnections between subjects and between school and the rest of the world. In innovative schools, the central project can be the stepping stone for experimenting with this theory.

On the other hand, the existing curriculum does not necessarily have to change. What changes is that teachers and students are asked to develop their assignments and projects around a specific central theme. Research papers, math projects, science experiments, social studies activities, art, drama, and musical presentations, and vocational projects are all developed around the central project.

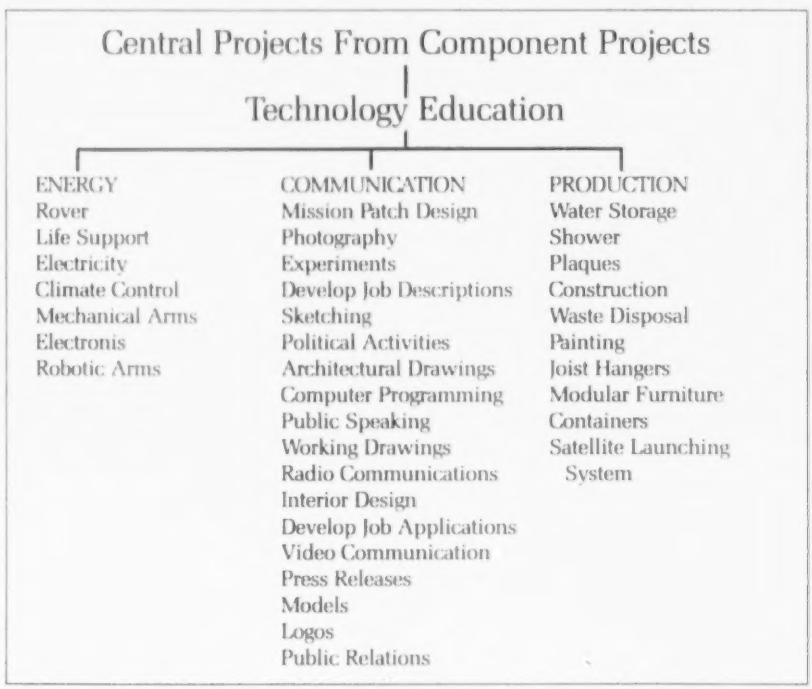



***FIGURE 1***
***Central projects from component projects***

Everyone in the school is aware of and involved in the project. Halls, bulletin boards, classrooms, and the cafeteria are all decorated and display information related to the project.

Excitement and commitment build throughout the community. As more teachers and students get involved in the project, community and parent support will grow, which should increase the likelihood of the project's success.

### Component Projects

The next criteria is that the central project consists of a number of component projects. Component projects allow students to personalize their educational experience by choosing a specific area of the project which interest them. Students gain mastery of a specific topic and display their knowledge in an observable behavior: the completion and integration of their component project with the central project.

Many proponents of education reform want to require students to demonstrate their achievement in order to be eligible for a high school diploma. The successful completion of a component project could be used as part or all of a required "Senior Project" (Boyer, 1983) or "Student Exhibition" (Sizer, 1986).

The number of component projects will depend on the number of students involved and the central project itself. Even a small central project can have a great number of component projects. It is important that each student in the class get involved in some capacity. At McCullough, we found that even lower-achieving students, once involved, became very excited about finding a place to fit in. If, by chance, there are not enough component projects to go around, different design teams can be formed to work on the same problem much like industries compete.

### Creativity

Each component project should be posed to the students in the form of an open-minded problem. We agree with Peters and Waterman (1982) that "the capacity to exercise a relatively high degree of imagination, ingenuity, and creativity in the solution of organizational problems is widely, not narrowly, distributed in the population."

Teachers should give the students a short list of design criteria and try very hard not to limit creativity. A well written component project problem description will not suggest any methods, materials or lead students toward any specific solution to the design problem. Students must actively seek the skills and knowledge needed to successfully meet the criteria.

Following this process will stimulate students to become more responsible for their own education as advocated by many leaders in education reform (Boyer, 1983, p. 129). As Adler suggests, teachers are no longer the "knowers who attempt to put the knowledge they have in their minds into the minds of their pupils" (1982, p. 50). Teachers may leave the didactic form of teaching and move into Adler's second and third column which employ the pedagogues of coaching and Socratic dialog.

Student questions should be answered with probing questions or one of our favorite responses "I don't know. What have you found?" At first students will dislike these teaching styles because most are accustom to getting immediate answers. These methods of teaching are powerful tools which help students to develop critical thinking and problem-solving skills. Students learn to follow the steps of the design process and to use the scientific method in order to develop projects.

> "These methods of teaching are powerful tools which help students to develop critical thinking and problem-solving skills."

### Recognition

The last but possibly most crucial element to the success of the central project model is recognition. In the survey of worker motivation mentioned above, full appreciation of work done received the second highest rating, right behind interesting work (Kovach, 1987). Students, like anyone else, want the recognition from their peers, teachers, family, and community members.

Unlike previous regional and state competitors, McCSA students received a great deal of attention for their accomplishment through the pep rally, extravaganza, and media coverage. Everyone in the school knew about the project and who had worked on it. Knowing that their component project will actually be used as a part of the central project and will be seen by their friends and family, students are motivated to do their very best.

They also realize that they are part of a team in which others are depending on them. Being a part of a team or group is extremely important to students. Each student involved received a certain amount of notoriety while experiencing the feelings of ownership that come from creating something new while they learn how to work in a team situation which is widely utilized in industry.

## Summary

The central project is an excellent model for implementing Technology Education and current educational theories. McCullough's Project Space Station was a great success because it was the right central project for that particular time and community. The space station and its components allowed students to pool information and apply their knowledge from various subjects and experiences while working on a meaningful and realistic project. The pep rally and extravaganza gave students the recognition they deserved for their hard work and permitted the community more access to school activities.

Our central project not only got students throughout the school involved along with their parents and many members of the community, but it actually got them interested and excited about what was going on at school. Any well chosen central project can help schools implement prominent educational theories and make Technology Education a reality while using existing equipment and making relatively small changes to the existing curriculum.

The central project a practical model which can put technology education and technology educators at the forefront of education reform. We are confident that the implementation of the central project model can make the change to technology education an exciting and very rewarding experience for students and teachers throughout the school and the community.

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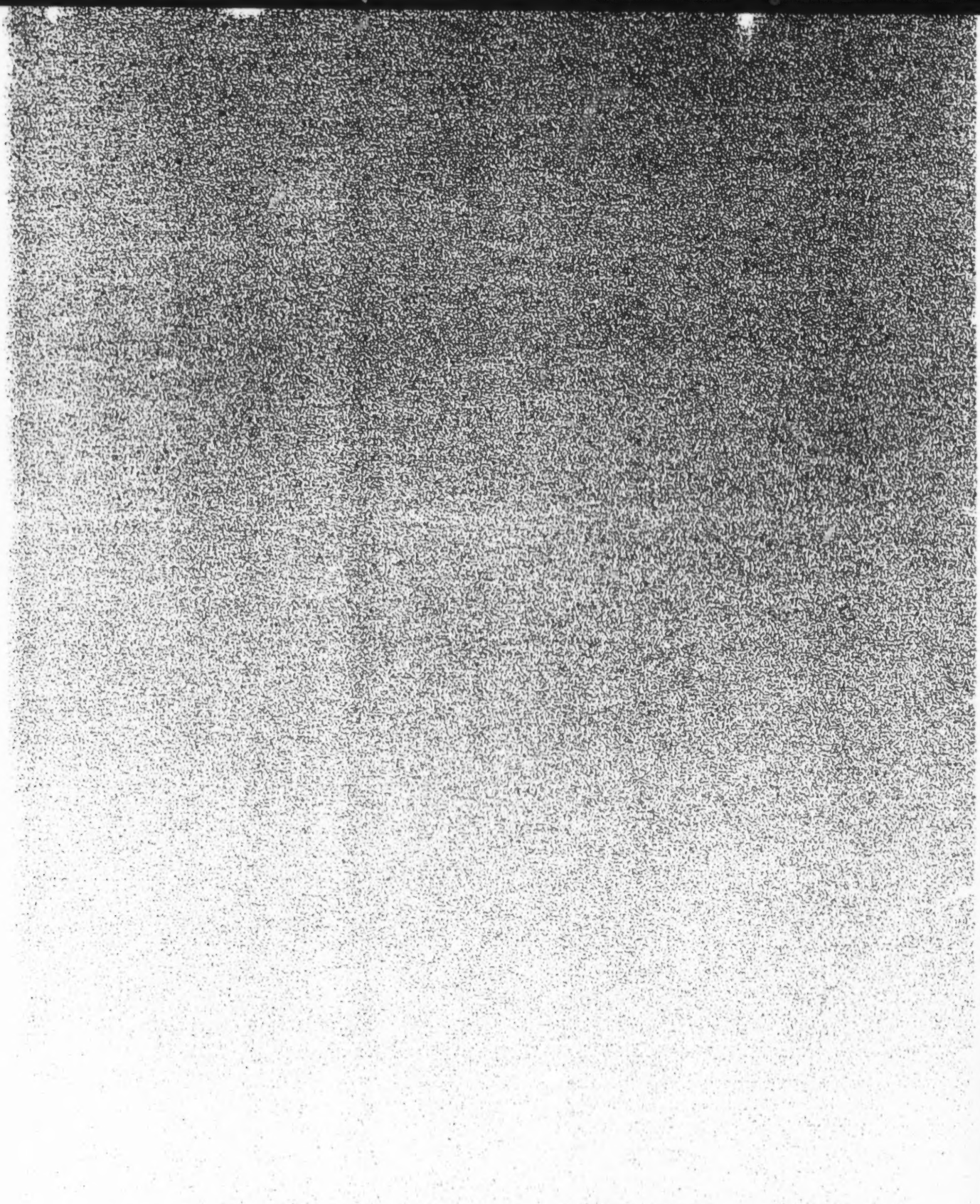

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